THE

ELECTRICAL REVIEW.

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THE TWEEDMOUTH COMMITTEE ON POST OFFICE ESTABLISHMENTS.

IT is perhaps not surprising that the Report of the Tweedmouth Committee on Post Office Establishments has not been received with universal satisfaction; who ever heard of a Parliamentary Report that has. When there are grievances to be remedied, and a Commission sits for the purpose, the report is anxiously looked for, and everyone expects to have his particular grievance put right on a liberal scale, and each one feels mightily aggrieved because what he anticipates, or rather wishes, has not come about. Indignation meetings are at once held, and steps are taken by resolution, and applications made to Members of Parliament, to have the wrongs, real or imaginary, put right. How far the protests, which we understand are being made by the telegraphists against the adoption of the scheme, or against certain provisions contained in it, are justified, we are not in a position to say definitely. One fact is plain, viz., that a large increase in expenditure has been sanctioned, which presumably will go into some people's pockets, and these must reap the benefit. One grievance, the existence of classification, which prevented advancement beyond a certain point unless vacancies occurred in the class above that point, has been, apparently, remedied, so that a telegraphist can now advance steadily from what was the minimum of one class to what was the maximum of the next class, the only bar being one of "efficiency," *i.e.*, at a certain point in the upward progress a barrier arises which would stop that progress unless "efficiency" had been proved. This, we presume, does not constitute one of the grounds of protest, unless it is thought that a telegraphist ought to receive increase of pay whether he is efficient or not, and doubtless some do think so! We note that one very substantial—and, for a Government Department, a very unusual—piece of liberality has been recommended, viz., the grant of a "double increment" when certain examinations have been passed. It has, we believe, often been a complaint by clerks who have had to submit to technical examinations before they are promoted from one class to another, that they have no encouragement given them to study technical matters. They would willingly study if there was some encouragement in the shape of a pecuniary prize to be gained; this complaint can no longer be said to exist if the recommendations of the Committee are carried out. A pecuniary prize of £6 (this being the amount of an increment) per year is the inducement for passing a technical examination, and a further double increment is also apparently attainable by those passing an examination in both sorting and telegraphy (manipulative, we believe). This inducement will be one which, we should say, is calculated to severely tax the department in regard to the conduct of the examinations, which will have to be very frequent and will require a number of skilled examiners. The

examinations, it is presumed, will be of a reasonably rigid character, and not simply "pass" examinations.

The adoption of these examinations will have much more than a mere departmental interest, as it will doubtless result in a large extension of the numbers who attend technical classes in which electricity and magnetism and telegraphy are taught, this especially in view of the fact that reasonable facilities for attending such classes are recommended to be given.

It is pointed out that in offices where the development of business is rapid, certain officers may be losers by the adoption of the abolition of classification, as past experience has shown that men in such offices have been promoted to the first class long before their maximum in the second class had been attained. It is not recommended that any compensation should be given to these officers for the loss that they may sustain. The abolition of classification has been demanded, and is recommended by the Commissioners in the interest of the service as a whole.

The same important change is also to be applied to the linemen, who will thus progress from a minimum of 24s. per week to a maximum of 40s.

HIGH SPEED ENGINES FOR MILLS.

Mr. Mark Robinson has been addressing the Manchester Association of Engineers on the use of high speed engines for mill driving—a fine subject, and one on which the victory of the aggressor is assured, for an engine that will drive a dynamo continuously, economically, and steadily, would drive a cotton mill as a holiday task, on the parson's friendly exchange system.

After repeating his text a few times, Mr. Robinson follows the usual practice to which we have become accustomed by many years of regular attendance at church, of leaving it to take care of itself, and of enlarging on the subject always nearest his heart, namely, "constant thrust."

This is the real prescription which he desires the Lancashire spinners to try; he does not even suggest that his friends, Bellis and Raworth, who say that "constant thrust" is the principal defect of the Willans engine, might possibly propose alternative prescriptions which would at least illustrate the text.

Mr. Robinson gives us an appalling list of the evils attendant on the use of high speed double-acting engines, and adds, "it must be allowed that the list of evils is a fair deduction from the behaviour of ordinary engines when run unduly fast." Our readers will endorse every word of this proposition, but we shall be much surprised if they do not immediately grasp the logical conclusion that the Bellis engine does not run *unduly* fast.

Later, Mr. Robinson advances this remarkable proposition: "The closed crank chamber is a luxury which can be thoroughly enjoyed only with a constant thrust engine; at least if very long runs are contemplated, for it is, or ought to be, a condition of its use that there must be no frequent necessity for adjustment of brasses."

We should like to suggest to Mr. Robinson that the closed crank chamber brings with it the possibility of such luxurious lubrication, that the necessity for adjustment of brasses ceases to be frequent. That this is the case in a Willans engine Mr. Robinson conclusively proves by the interesting facts which he adduces as to the extremely small wear of the bearings, which very curiously, and we think quite illogically, he attributes to constant thrust, disregarding the fact that there are millions of bearings at work under constant thrust carrying fly-wheels, line shafts, &c., in which the wear with ordinary lubrication is not abnormally small, while on the other hand, with Mohler's bearings, in which the lubrication is profuse, the wear is quite negligible.

Further, Mr. Robinson ignores Mr. Morcom's evidence on this point (May 23rd, 1895, Vol. xxiv., Inst.E.E) "The engine at Messrs. Siemens's I saw myself opened up. It had been running two years; the bearings were not altered. There had been no wear and no adjustments necessary."

This was a double-acting Bellis engine.

Turning to the question of clearance, the author says:—"The adoption of the Corliss valve would afford a satisfactory remedy as regards clearance." But it seems rather late in the day to say "*would afford*."

Two or three years ago this sentence might have raised the author to the ranks of a prophet; possibly it might have proved the germ of a Robinson Universal engine.

Happily Mr. Robinson's papers are excellent reading, and although this one falls a little below his paper of May, 1895, in elegance of composition, it is still very much above the average; its strong point is facts, its weak point is logic.

Driving Alternators in Parallel.

The electric lighting plant at the new station at Wandsworth, belonging to the County of London and Brush Provincial Electric Lighting Company, possesses some novel and interesting features. This is the first electricity supply station in which two Universal engines driving alternators have had the opportunity of being tested together in parallel. The special feature of interest lies in the fact that the engines have each only one crank, and a very general belief exists that single crank engines are unsuitable for such work, particularly when coupled direct to the alternator. From our own observation a fortnight since, we can confidently affirm that this question is finally settled by the complete success of the Wandsworth installation. Not only is the parallel running good, but the ammeter needles remain practically steady, the variations being discernible only on close inspection. At present only two engines are at work, but four other sets are in course of erection. The alternators are of the well known Mordey-Victoria pattern, with copper armatures and revolving fields; the engines are of 300 H.P. each, and have 19 and 32-inch × 14-inch cylinders, they may, therefore, be classed as large engines, for a two-crank engine of these dimensions would indicate 600 horse-power. During our stay the machines were worked through a water resistance, up to an output of about 120 kilowatts, and we understand that at full load the running is even better than what we saw.

A Gift to Science.—We learn from the *Daily Chronicle* that M. Solvay, the well-known Senator for Brussels, who owns large industrial establishments in the neighbourhood of Nancy, has given 100,000 francs to the University of that city for the purpose of erecting a chemical and electrical laboratory.

MAGNETISM FOR ENGINEERS.

When the physicists and mathematicians—to whom all honour is due—brought our knowledge of magnetic principles to its present state, the language in which they clothed the exposition of these principles was such that, in the way of a clear understanding of magnetic matters, it has ever been a stumbling block to the average electrical engineer. For this misfortune no one is, strictly speaking, to blame; the scientist and the engineer look at things from such totally different points of view, that it is not to be wondered at if their methods of reasoning are dissimilar. But when the engineers, with the assistance of the Drs. Hopkinson and others, at length found a practical way of considering the question, by making use of the analogies existing between the magnetic circuit and other circuits of which they had had experience, they received—and quite naturally, no doubt, since even scientists are human—no support from headquarters; and moreover, when the electrical engineers—carried away by their superabundance of youthful enthusiasm—went too far, and discovered Ohm's law analogies in every apparent resemblance between sets of symbols, they were greeted only with the silence of contempt, and allowed to lose themselves in their crooked ways. Text-books, even to this day, continue to discuss the properties of *free* magnetism, and the behaviour of imaginary emancipated unit poles, to the deep and everlasting confusion of the unfortunate student.

In the following pages we shall endeavour to elucidate some of those conceptions of the scientific mind, which are a frequent cause of bewilderment to the electrical engineer who wishes to extend his knowledge of magnetic matters beyond what is usually considered sufficient for the purposes of dynamo design.

If it is clearly understood that the present article is written for the benefit of engineers, who do not see things in the same light as the pure scientist, but only as in a glass, darkly, much of what might otherwise appear childish, and therefore, of course, superfluous, will stand a better chance of being judged at its true value.

Regarding our estimate of the intellectual powers of practical electricians and engineers, it must not be supposed—for perhaps we have not expressed ourselves quite clearly—that we consider these to be of an inferior order; on the contrary, an engineer, even though he may be fond of empirical formulæ, and may use various means to an end which are far from scientific, generally knows what the results of his calculations mean. If by some mischance this meaning is not clear to him, he is naturally at a disadvantage on account of his (probable) want of the necessary mathematical knowledge; but it is, nevertheless, a noticeable fact that he is inclined to be unhappy until he has cleared up the difficulty, and this he generally succeeds in accomplishing by some method of logical reasoning peculiar to himself.

Let us, in the first place, endeavour to throw a little light on the respective meanings of the symbols H and B. When a current is passed through a coil of wire, the coil becomes a source of magnetism; it may be looked upon as the force to which the magnetic condition of the surrounding medium is due. The strength and direction of the magnetic field at any point are fully defined when we are told what is the magnetic *induction* at the point considered.

A magnetic field may be conveniently represented (after Faraday) by *lines* or *tubes* of induction. Each unit tube of induction being replaced by a line passing down the centre of it, it follows that the *intensity* or *strength* of the field is everywhere proportional to the closeness, or density of these imaginary lines, while the resultant *direction* of the magnetic force at any point is that of the tangent to the magnetic lines at the point considered. The number of such unit magnetic lines per square centimetre of cross section is, therefore, a measure of the magnitude of the magnetic induction. When the magnetic field is measured in a vacuum, or in air, or any known substance, with the exception of iron, nickel, or cobalt, the induction is practically proportional to the magnetising force, and it is denoted by H; but, when it is measured in iron, it is no more proportional to the current in the coil, and it is now denoted by B.

Consider a helix, or solenoid consisting of a uniformly wound coil of wire of n turns per cm., this helix being bent round so as to form a closed coil having an air core of the shape known as an anchor ring. Let its mean periphery be l cms. Then, if c is the number of amperes passing through the wire, the value of H at the interior of the coil is found (experimentally) to be given by the expression,

$$H = \frac{\frac{4\pi}{10} n c \times l}{l}. \qquad (1)$$

The quantity $\frac{4\pi}{10} n c \times l$ has been called the magneto-motive force, as it is the force to which the *flux density* H is due. The analogy between such an arrangement, and a tube filled with mercury through which a current of electricity is passing, is so evident, that it is unnecessary to dwell upon it. We have merely to replace the *magneto*-motive force (M.M.F.) by the *electro*-motive force, and we obtain the expression:—

$$\Delta = \frac{\text{E M F}}{l},$$

where Δ stands for the current density in the mercury on the assumption that the specific resistance of the mercury is unity.

Returning to formula (1), we see that the flux of induction in a magnetic circuit which does not contain iron or any other "magnetic" material is governed by a law similar to that of Ohm for the electric circuit; the specific resistance of a vacuum or of air, or other "non-magnetic" substance, being taken as unity.

We are now in a position to explain the meaning of an expression occasionally to be met with in text-books, which is a frequent cause of bewilderment to the student or electrical engineer. We are told that, in air, "the magnetic force and magnetic induction have the same direction, and mean the same thing."

Now, by again inspecting formula (1), it will be seen that H does not depend on the *length* of the magnetic circuit, but is simply proportional to the ampere turns per centimetre. Hence H is a measure of the magnetising ampere-turns *per centimètre*, which we have written $n c$. But both the expressions, "magneto-motive force," and "magnetising ampere-turns per cm.," are lengthy, and to a certain extent unscientific. Let us therefore (for simplicity) divide what we have called the M.M.F. by l, and call the result (for shortness) *the magnetic force*. H is then not only a measure of this magnetic force, but it is numerically equal to it; we may in fact say, with a *very* slight straining of the imagination, that H *is* the magnetic force. Thus we see that, although we might have racked our brains in vain for any simile, however far fetched, wherein the cause producing an effect, and the effect itself are identical, this peculiarity of the magnetic circuit is as simple to understand as many another seeming mystery, once it has been properly explained. This is only one of the many instances of the danger and uselessness in always being on the look out for some suitable analogy which may help us to get an understanding of what is new to us.

This conception of what has been called the magnetic force is, moreover, a very convenient one, because the magneto-motive force is the line integral of the magnetic force taken round a closed line; and further, the line integral of the magnetic force along a line 1 cm. long is simply the magnetic difference of potential per cm. which causes an induction of H lines per sq. cm. in air.

We have spoken of a *closed* magnetic line, and it will, perhaps, be unnecessary to remind the reader that every imaginary line or tube of induction must be considered as a closed line or loop. This, at least, is the usual way of stating the case; it is, however, not a strictly scientific conception. Instead of saying that the lines of induction are closed lines, we should say that "the tubes of magnetic induction must be either in the form of closed solenoids re-entering into themselves after traversing a finite distance, or else in the form of endless solenoids which proceed to infinity."

This information, regarding the behaviour of what, in vulgar parlance, we call magnetic lines, ought not to discourage the student of the phenomena and principles of magnetism; for he has but to remember that those lines which leave one end of a magnet on their (apparently) endless journey do, as a matter of fact, always come in again at the other end; a state of things which, although it may lead to some interesting conclusions as to the nature and dimen-

sions of infinity, does not seriously interfere with the more elementary ideas concerning the conservation of the flux of induction.

Having briefly considered the meaning of the symbol, H, we will now attempt to clear up one or two obscure points on the subject of B. This symbol, as is well known, is generally used in England to denote the magnetic induction when this is measured in iron. It is the resultant flux of magnetism per sq. cm. due to all the magnetising forces which are acting, or have once acted, upon the piece of iron in question. It varies considerably with the quality and condition of the iron, and it is only approximately proportional to the magnetising forces between certain more or less variable limits. The Ohm's law simile, therefore, fails us here, and as a matter of fact, the conditions producing a given value of B in a given sample of iron must always be determined experimentally. If, in the closed solenoid already described, we imagine the air core to be replaced by an iron one, the induction is greater than it was before, and we may put

$$B = \mu H,$$

where H is the induction obtained with the air core, and μ is a multiplier which has been called the permeability.

This seems simple, but in reality it is not so. In the first place, μ is not a constant, but depends, among other things, upon the value of B itself; and in the second place, it is extremely unscientific to think of B otherwise than divided up into its constituent parts. These parts are $4\pi I$ and H; thus

$$B = 4\pi I + H,$$

the meaning of which expression is clearly understood when we are told that I is the magnetic moment of the iron per cubic centimetre, and H is the magnetic force, or number of lines per sq. cm. which would be found in the place of the iron, if the iron wasn't there.

A little consideration will make it evident that—since we have no reason for supposing that the number of lines *due to the coil* will disappear when the iron is introduced, the expression $4\pi I$ represents the number of lines *added* by the iron, and which we may assume owe their existence to the magnetic condition of the iron itself. I is therefore a measure of the physical condition of the iron; it is best defined as the intensity of magnetisation of the iron, and it is a quantity of much scientific value. It is, however, of little interest to the engineer, whose chief use of magnetism is to produce *inductive* effects. He is therefore more interested in the quantity B, which has been aptly called the *induction*, and he is inclined to entirely ignore, or even—with a sense of superiority born of ignorance—to ridicule the fundamental division of B into its constituent parts; a condition of things which, one can readily conceive, may be a trifle annoying to the scientists. The latter, however, most undoubtedly placed themselves in a disadvantageous position, when one of their side referred to this division of B into $4\pi I$ and H as being "no doubt highly artificial." It is surely adding insult to injury to inform the struggling student, who has valiantly fought his way through a mass of more or less meaningless hieroglyphics, that the particular expression which strikes him as above all things senseless, is "highly artificial." He supposes it is introduced for the amusement of the master mind, which thought irritates him, and it is not to be wondered at if he joins the ranks of those degenerate outcasts who see a resemblance to Ohm's law in the relation between all natural phenomena and their causes, and who use the term "magnetic resistance" without obtaining permission to do so from head quarters.

The multiplier, 4π, is undoubtedly a trifle exasperating; but our system of units makes it necessary, and if we consider the magnetic state of a bar of iron, which we have called I, it is necessary, in order that we may denote by H the strength of the field surrounding the ends of the bar, that we should consider $4\pi I$ lines traversing the centre portions of the bar.

Let us now consider the meaning of the expression $B = 4\pi I + H$ when it is applied to permanent magnets.

If a ring of iron or steel is magnetised to what may be considered the saturation point, and the magnetising force is then removed, the iron will retain a certain amount of *residual* magnetisation which may be expressed as a percentage of the saturation value. The magnetic force which has to be applied in order to reduce this residual magnetisation to zero, has been called by Dr. Hopkinson the *coercive force*. If the sample experimented upon is not a ring, but a straight bar of no very great length as compared with its section, the residual magnetisation—after it has been magnetised to the same (saturation) value as the ring—will now be less; but the coercive force will be the same, provided the material of the sample is the same as before; in other words, the ampere turns per centimetre required to entirely demagnetise the sample, are not dependent upon its shape. If, in the case of the ring sample, we had not only removed the magnetising force, but had applied a demagnetising force equivalent to that required to overcome the resistance of the air path in the case of the bar magnet, the magnetisation left in the ring would have been the same as that in the bar. Moreover, the fact that the same reversed ampere turns must be applied to demagnetise both the ring and the bar, is only what we ought to expect when we remember that, although in the case of the straight bar, the residual magnetisation is less, the demagnetising ampere turns have the resistance of the air path to overcome in addition to the hysteresis of the iron.

These considerations suggest a method of treating the question of permanent magnets more likely to find favour with electrical engineers than the purely academic methods which involve the ideas of free magnetism, and the demagnetising forces exerted by the end elements of the steel. That the latter methods sometimes present difficulties to the non-mathematical reader may be gathered from what follows.

We are told to consider a magnetised iron ring, the lines through which are $4\pi I$ per sq. cm. This ring is now supposed to be cut and straightened out. The lines of magnetisation, we are told, are still $4\pi I$; but there will be lines of force running through the iron in the opposite direction, due to the free magnetism which adheres to the ends of the bar. We are therefore instructed to think of two groups of lines passing through the metal of a permanent bar magnet, one group being represented by $4\pi I$; the other by H, and these two groups of lines thread their way through the metal in opposite directions. Further calls are made on the imagination when we are told to picture in our minds an infinitesimally narrow gap, supposed to be cut through the body of the magnet. This is done for the purpose of giving us a clear idea of what is meant by B, for we are requested to count the total number of lines per square cm. crossing the gap, which number is said to be a measure of B; and it is evident that we are expected to make it $4\pi I - H$. We, ourselves, not being gifted with a mathematical mind, have never been able to understand this; our total always comes out $4\pi I + H$.

When we think of an alternating current which is more or less out of phase with the E.M.F. producing it, we sometimes, for convenience, and for power calculations, divide up the current into two parts, the *work* component and the *wattless* component; but we do not *picture* to ourselves two distinct currents flowing in the circuit. For the same reason, *i.e.*, to prevent confusion, electrical engineers will find it safer to picture only the *resultant* magnetic field, as it is represented by *one* system of lines, the direction and closeness of which are a measure, at any point, of the direction and strength of the magnetic induction.

In a permanent steel magnet the physical condition of the metal is such as to tend to create a magnetic field in a certain direction, and in this respect it may be compared with a coil of wire through which an electric current is passing; other causes, such as the resistance of the magnetic circuit, and the magnetising forces of neighbouring electric currents or permanent magnets, will determine the actual value of the induction in the body of the magnet itself.

With reference to the term "magnetic resistance" which we have unblushingly introduced in this article, we may say that we do not think it necessary to apologise for the use of it, seeing that we are writing for electrical engineers, who *all* use and understand it.

At first sight the expression appears harmless; but it has led to so many heated discussions, and so much bitterness and sarcasm and uncharitableness, that we may be excused for dwelling upon it at some length.

In the first place—and in order to save the useless expenditure of ink and paper—we will define what we understand by magnetic resistance as that attribute of the magnetic cir-

cuit, or portion of magnetic circuit, which stands in the way of the establishment of an infinite flux of induction. If the various portions of a magnetic circuit offered no resistance to the establishment and maintenance of the magnetic state, there would be no limit to the value of B.

Now, unless we were expressly informed of the fact, we should not ourselves conclude (1) that this resistance is constant under all conditions; and (2) that it involves a continuous expenditure of energy, even after the magnetic field is established, and has reached a steady value. Yet the scientists tell us that these ideas are invariably associated in their minds with the term resistance, and do what they will, they cannot get rid of them. Of course, under these circumstances, it would be unwise of them to use the expression, and if they consider themselves competent to deal with such a mouthful as "magnetic-reluctance-function," no one would be so foolish as to deny them the use of it. Our sole argument is that the engineers have as good a right to use the word "resistance," if it pleases them to do so.

The man who says that the total flux of induction through a magnetic circuit is the quotient of the magneto-motive force and the total magnetic resistance of the circuit, makes a statement which is true, and which does not, and never will, stand in the way of the proper understanding of magnetic matters; but if he deceives himself into believing that he has got hold of an expression which is the equivalent of Ohm's law for the electric circuit, we can only conclude that his intellectual faculties are not of such a high order as might be desirable. The whole essence of Ohm's law is the constancy of the electrical resistance whatever may be the strength of the current in the circuit; and this applies to all electric circuits, whatever may be the metal or metals of which they are composed. Such a miracle as this does not constantly repeat itself in nature; and when we find that iron, when subjected to increasing magnetising forces, shows unmistakable signs of tending towards a condition of saturation; in other words, that its magnetic resistance increases more or less in proportion to the magnetising force itself, we ought not to be surprised; nor should we say that, on account of this abnormal behaviour on the part of the magnetic circuit when the path of the induction happens to be through iron, we must on no account use so vulgar a word as resistance, but we must coin a new expression, such, for instance, as "magnetic-reluctance-function," which may be truly worthy of the phenomenon with which it is associated.

The scientists object that when we speak of the magnetic resistance of the iron, we speak of something which has no physical meaning, as it is not an attribute of the metal itself; that is to say, it does not depend solely on the nature or physical condition of the iron. Without questioning the wisdom of this statement, we will confine ourselves to pointing out how the difficulty has been got over; it may suggest new lines of thought to the practical man. In order to avoid the use of such a conception as the magnetic resistance of a centimetre cube of iron, which has no physical meaning, we are instructed to think of its reciprocal, the magnetic conductivity (or permeability). This is a delightfully simple solution of the difficulty, as well as a useful one, especially as the reciprocal of the conductivity (or permeability) will, in its turn, give us the thing we want—but without naming it.

ELECTRIC TRAMWAYS AT ARGENTINA.

[FROM OUR SPECIAL CORRESPONDENT AT BUENOS AIRES]

The chief matter of electrical interest in this country just now is the commencement by La Compañia Tramways de la Capital to lay the rails which are to form the first electrical tramway in Argentina.

Although many people have applied for concessions to run electrically propelled cars in different parts of the city, up to the present no active work has been commenced, except by the company already mentioned. This company, which was floated in the United States, contemplates constructing an electric tramway some 26 miles in length, traversing some of the most important streets of the city, and forming a means of communication between the middle of the town and some of the more populous suburbs.

In the town proper, or at any rate in the more important streets, a conduit system, or insulated rail running along the side of the track, will be employed. In the outskirts of the town, however, and in the suburbs an overhead conductor will be used, no objection being made by the authorities to this method except in the centre and more important parts of the city. The conduit and overhead conductor are to be supplied with current at a pressure of about 500 volts from feeding stations situated at regular intervals along the entire length of the line. These feeding stations are themselves to be connected to the generating station by rubber insulated armoured cables drawn into an underground wood conduit having a round internal and a square external section. The use of armoured cables for this purpose has been a good deal criticised, many engineers thinking that if any additional covering outside the vulcanised rubber was necessary lead should have been used on account of its superior lasting qualities, and also because the mechanical protection afforded by steel armouring is not required by a cable laid in the thick wooden conduit already referred to.

The drawing-in boxes for the feeder cables are to be situated about 110 metres apart, and are to be specially constructed after a North American design, the object aimed at being to ensure an absolutely dry box. Arrangements are also made for ventilating the boxes by pipes led from them up the side of any adjacent building, thus reducing to a minimum the chance of gas accumulating in the box.

The work of laying the tramlines and feeder conduits is being pushed on with as much speed as possible, and it is hoped that by June this year some 16 miles of track will be completed, and that the erection of the machinery at the generating station will be sufficiently advanced to enable current to be supplied at that date.

As the metals themselves have to act as the return conductor, considerable attention is being paid to the joints between the rails, and in order to make these as electrically perfect as possible, a patent bond is being employed, which is said to make an entirely satisfactory and lasting metallic connection, and to have as low an electrical resistance as the rail itself.

The tramcars are to be of the double deck pattern designed to accommodate 52 passengers and propelled by two 25 horse-power motors geared respectively to the axles of the two bogeys carrying the frame of the car.

The generating station is well situated not far from the centre of the district traversed by the tramway, and the plant itself consists of four watertube boilers by the Stirling Watertube Steam Boiler Company, having a joint capacity of 950 effective horse-power and a working pressure of 140 lbs. per square inch.

The engines, of which there are three, are manufactured by Messrs. Ball & Wood, of New Jersey, and are high speed vertical compound engines of 450 effective horse-power, each direct coupled to a 300 kilowatt continuous current dynamo manufactured by the Walker Manufacturing Company, of Ohio. These dynamos, which generate current at 500 volts pressure when on open circuit, are compounded to give 550 volts at their full working output of 550 amperes.

It is estimated that two of these dynamos will be sufficient to supply current to all the cars that will be running on the line at any one time, so that one complete set, *i.e.*, one dynamo and engine, will always be at rest, and can be used as a spare in the event of an accident happening to either of the other two sets.

Since the total boiler capacity of the station is only 950 horse-power, it is inevitable that when two of these 450 horse-power engines are working at full load all four boilers will be required, and there will be none left to use as a stand-by; it is not, however, contemplated that at first, at any rate, enough cars will be running to necessitate two engines being worked to their maximum output, and probably three of the boilers will be able to keep steam for the two engines working at normal load, which will allow of one boiler being unoccupied and being ready in case of a mishap occurring to any of the other three.

It will be observed that the whole of the orders for boilers, engines, dynamos, cars, cables, &c., indeed, for the whole plant for this tramway have been placed in the United States, and although English firms have tendered for the supply of

different portions of the machinery, they have not in any single instance been successful. This may no doubt be accounted for to some extent by the fact of the Tramway Company itself being an American one, and by American engineers and manufacturers having had greater experience in traction work of all kinds than can be claimed by their rivals in England. It is, however, to be hoped that English manufacturers will supply, at all events, some of the material which will be required for the other electrical tramways which must inevitably follow the successful opening of this one.

THE AUTOMATIC EXTINCTION OF LAMPS.

There is little doubt that an arrangement of street lighting which permits of the illumination being reduced at midnight, or at any other time when the streets require less light, is a convenient and economical one. In carrying out this idea, some towns have arranged that the arc lights shall be extinguished at midnight, and that the lighting shall then depend on incandescent lamps. Portsmouth is a notable instance where this method has been adopted, and with a considerable amount of success. It will be remembered, no doubt, that each lamp pillar carries an arc lamp as well as two incandescent lamps; the arc lights being turned off at midnight and the incandescent lamps being put on. It is clear that either some elaborate means of bringing these lamps into use must be adopted, or a man must be sent round at the specified hour to put on the incandescent lamps. It would, of course, be possible to do all this at the works, if the incandescent street lamps were on a separate circuit; but to put down special mains for this purpose would scarcely be justified under most circumstances. Where the street lighting is not too scattered, a man on a bicycle provides the best means of turning on the lights, but beyond a certain area it is practically impossible to use this method, because if one man has to go round to each lamp, it must take him a considerable time to turn on the whole of the lights, and it is not until he has visited the last lamp that the whole of the arc lights can be extinguished. In a system of street lighting of considerable magnitude, the question of automatic switches for turning on the lights becomes a practical one,

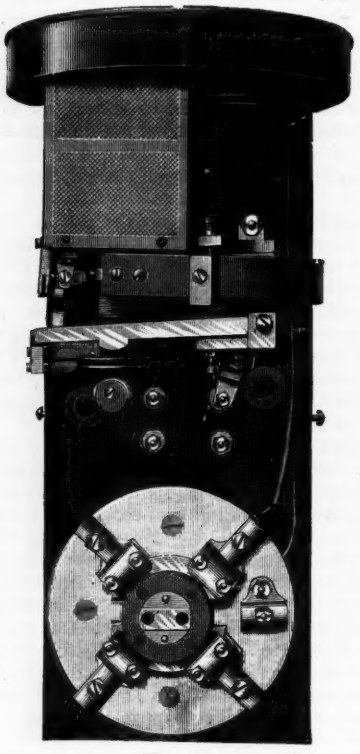
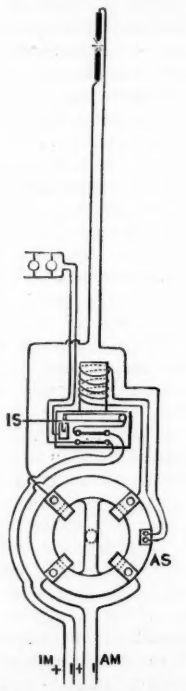


Fig. 1.

and in this respect it is interesting to note what has been done at Portsmouth. The automatic switch which is being used on 240 lamp posts, is designed so that when the arc lamps are turned off the incandescent lamps are automatically lighted. The device consists of a coil in series with the arc light, and when the arc lights are burning the coil becomes energised, and attracts the end of a lever; when, however, the arc lamps are extinguished, the rocking arm drops down into a knife-edge switch, and this action has the effect of completing the incandescent circuit, thereby turning on the glow lamps. An idea of the arrangement of the device will be obtained from fig. 1; the circular switch at



I S, Incandescent switch; A S, Arc lamp switch; I M, Incandescent mains; A M, Arc mains.

Fig. 2.

the base is for the arc light, the rocking arm being a little higher than the middle of the board. It will be seen from the diagram of connections, fig. 2, that the arc light current passes to one segment of the switch, and across to the opposite segment; from thence it passes to the series coil, returning to a point shown on the right of the circular switch. The current next passes to the arc lamp and back again to the connection shown on the left side of the switch, thence across to the

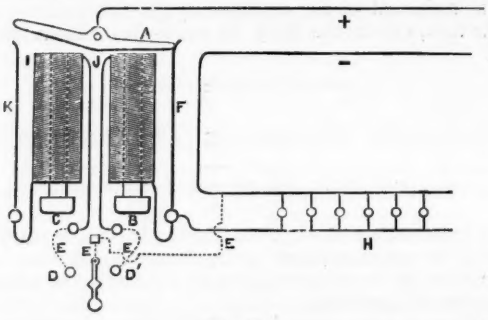


Fig. 3.

opposite segment and on to the return conductor. It will be seen that if the lever drops, the incandescent circuit is completed through each end of the arm, the current passing through a fuse straight to the lamps, returning to the switch through the arm of the lever and out again. The operation is a fairly simple one, thus far, but though the in-

candescent lamps are put on easily enough, it is necessary, when darkness has passed, that they should be turned off, and this must be done without the necessity of burning the arc lamps. This is provided for in the following manner:—When the time arrives for the incandescent lamps to be turned off, a reverse current is sent through the arc lamps and consequently through the coils; this has the effect of lifting the lever out of the switch, thereby cutting out the incandescent lamps; it is important, however, that the lever should not fall back on to the switch, because it is obvious that the incandescent lamps would light up as soon as this happened, because the low tension mains to which the glow lamps are connected are always alive. This is prevented in a somewhat ingenious manner. There is just under the solenoid a permanent magnet, which is pivoted in such a way that it is free to move in a horizontal direction; there is attached to the end of the permanent magnet a lever or catch, the use of which will be seen. When the reverse current is sent through the coil, the permanent magnet moves forward, and the catch passing under the rocking arm, which has, of course, been attracted upwards, prevents it from falling back on to the incandescent switch, when current ceases to pass through the series coil, though the core of the solenoid drops down again to its original position. The reverse current is sent through the lamps for about five minutes, and then stopped, the lamps being thus effectually cut out of circuit. At night when the ordinary lighting current is sent through the lamps, the pivoted permanent magnet moves back into its original position, and permits the lever to act according as the coil is magnetised or demagnetised. It is a proof of its efficacy that its introduction into Portsmouth has probably saved the wages of three men, for when there were only 110 lamps in the streets, two men were necessary to attend to the turning on and off.

It should be mentioned that the idea of the above switch originated with Mr. Henry Edmunds, of Messrs. W. T. Glover and Co., and the details of it were worked out by Mr. Howard, of the same firm.

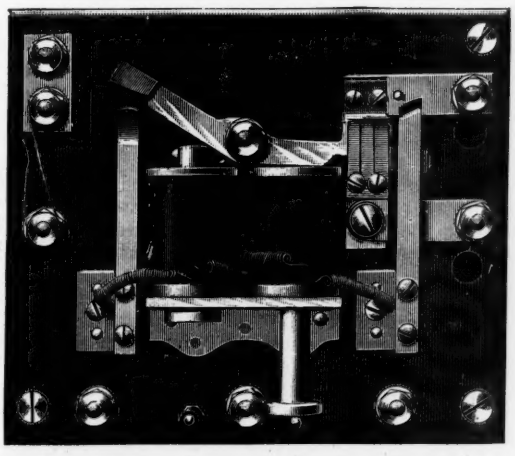


Fig. 4.

Another form of magnetic switch has been designed for completely controlling incandescent lamps in buildings. It has been designed to take the place of a master switch, and while the control of the switch may be done from, say, a top floor of a building, the switch itself might be placed in the basement. The switching apparatus takes the form of a double solenoid, which by the action of plungers forces a switch in and out of contact. The arrangement of the apparatus will be seen in fig. 3, while the general appearance of the switch is shown in figs. 4 and 5. Referring to fig. 3, it will be seen that at the position shown, current comes to the middle of the double arm rocker, and passes along arm, A, through the lead, F, to the lamps, H. The handle of the switch; it may in some cases take the form of a push button, is in permanent connection with the negative side of the lamp mains; if, however, the handle were pushed to the right until it touched D^1, the right-hand solenoid would be put in series with the mains, and a current flowing through it would energise it, with the effect that plunger, B, would be sucked in with such violence that its extreme end would push A out of contact with F, thus effectually cutting the lamps out of circuit. The switch returns to its original position immediately; indeed, the important feature of the switch is, that it breaks its own contact, so that there is no sparking at the push button. It will be seen that the above operation has pushed the arm opposite A into contact with K, and if it were required to turn on the lamps, the switch handle would be

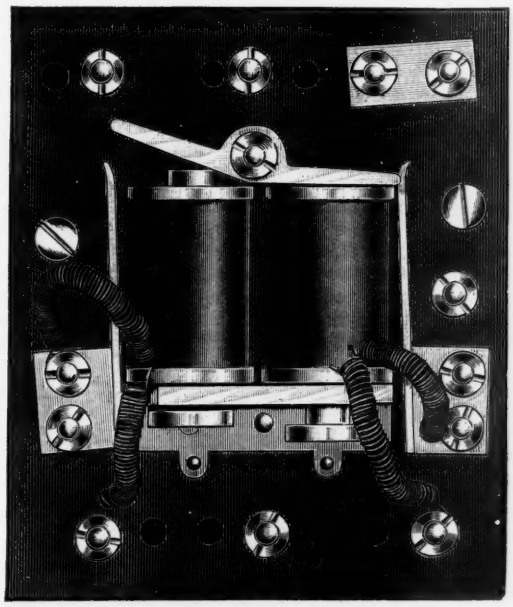


Fig. 5.

turned to the left to make contact at D, and the current flowing down K would energise the left-hand solenoid and draw in plunger C, with the result that the arm would be pushed off, and arm A would make contact with F, and the lamps would be turned on, or put into such a condition that they could be turned on. It is a notable feature in the switch that, as the current is only on momentarily, it is possible to use much greater energy in a small coil than is ordinarily possible; indeed, it is quite a usual practice to send through the coils without injury current equivalent to a tenth of a horse-power.

The essential feature of this switch is that its employment obviates the necessity of running the heavy main cables up through the building, as only very small wires are necessary to actuate it.

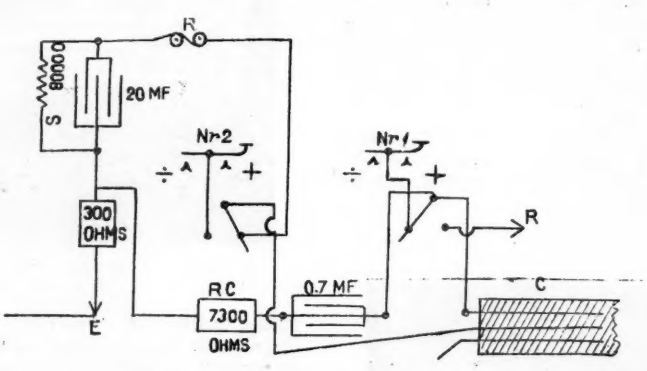
ELECTRICAL ANNEALING OF HARVEYISED ARMOUR.

Harveyised armour plate is so made by the introduction, by cementation, of carbon into the face of a mild steel plate. This is then water hardened, and the hardening extends an inch inward, and is devised to break up projectiles before serious penetration can take place. The bolt holes cannot well be drilled until a plate is fitted, and the locus of each bolt had formerly to be protected against cementation; but the precautions sometimes failed, and it was very difficult to drill and tap such hard plates, and all attempts at softening failed. The Thomson Electrical Welding Company, says Mr. Dougherty in *Cassier's Magazine*, have now softened such plates by sending currents of large amperage though the spots to be annealed. This raises the area to 1,000° Fahr., and draws the temper; but the current has to be gradually withdrawn, or the heat is conducted away by the surrounding metal so quickly, that no annealing could take place.

The dynamo employed gives a 300-volt current at 100 amperes, with 50 cycles frequency per second. The fields have a separate excitation of 110 volts, with a maximum current of 15 amperes. The current in the transformer has a rheostat regulation. Two No. 6 B. and S. wires carry current from the generator to the primary coil of the transformer, and two No. 8 wires extend between rheostat and fields. The annealer is a copper-clad transformer, in which the secondary is composed of two copper castings, which, when bolted together, form a closed rectangular frame containing the primary, the space between the two containing a heavy oil "Transil" acting both as heat conductor and as insulator. The arrangement affords excellent mechanical protection, and prevents electrical and magnetic leaking. The conversion ratio is 100 to 1, and the primary is a copper ribbon between coils of thin asbestos.

The transformer is swung in trunnions or gymbals. The contacts are of forged copper, water cooled, being hollow, and terminating in a narrow tip rounded out at the end. The total weight is 1,000 lbs., sufficient for contact pressure on a horizontal surface. Contact on other surfaces is secured by wedging from adjacent objects.

Though the contact surface is rarely over half an inch square, the copper will carry a flow of 10,000 amperes, equal to 40,000 amperes per square inch, a rate only possible by reason of the water cooling. In the annealing process the contacts are put into touch on either side of the spot to be annealed. The primary is brought up to 75 to 10 amperes for 4 or 5 minutes, until a pine stick will fire when put in contact with the plate. The rheostat is then turned one point per minute, until all resistance is placed in circuit, thus securing the necessary slow cooling. The total operation takes 15 minutes. Any shape of hole can now be cut in a plate by annealing a series of spots in the line of cutting. A plate can be cut by drawing the annealer along the line of cut slowly enough to allow gradual cooling behind it, when the plate may be cut along the softened track. A speed of about an inch in 4 minutes is a correct speed for line work, and the copper contacts cut a chip in front of them like that of a planer tool. In the *Iowa* battleship nearly 2,000 holes have been annealed in three months by two sets of plant working night and day and Sundays, which looks as though Uncle Sam was in a hurry to be quarrelling.



R, relay; S, shunt; R C, retardation coils; C, cable.

THE GERMAN-NORWEGIAN CABLE.*

By ALB. PETERSEN,
Telegraph Engineer, Norwegian Government Telegraphs.

The three-cored German-Norwegian cable was laid in 1879 from Stölsvig, in Norway, to Hoyer, in Germany.

By means of landlines in Germany and Norway, one of the cable cores was utilised for direct communication between Arendal and Hamburg, while the second core gave Christiania alternate connection with Hamburg and Berlin, translators being employed at Arendal and Hamburg. The third core was not in use for some years, but was later on employed for direct work between Arendal and Berlin with translators at Hamburg, while at the same time Christiania used core No. 2 for communication with Hamburg only.

The system used at first was the single current Morse with weak wiping-out current (zinc), P.O. standard and Siemens's relays as receivers. Fifty Meidinger cells were used as main battery, and about thirty Meidinger cells for the wiping-out current.

By means of this system and the original landline arrangement, the telegraphic connection between Germany and Norway was well maintained; but later on, when the landlines in Germany were replaced by underground cables, the original battery strength was found to be insufficient, but could, on the other hand, not be increased to any appreciable extent on account of the disturbing induction between the cable cores.

After the landlines had been replaced by underground cables, the lines were composed as follows:—

	Km.	Resistance. Ohms (obs. temp.)		
Landline from Arendal to Stölsvig	10	...	70	
Submarine cable from Stölsvig to Hoyer	467·7	...	3,025	Capacity, 128 microfarads.
Underground cable from Hoyer to Kiel	148·8	...	1,205	
Underground cable from Kiel to Hamburg	99·2	...	697·5	

Total—725·7 km.; 4,997·5 ohms (obs. temp.); 128 microfarads.

The K.R. of the line thus becomes 639,680.

The cable from Ireland to Newfoundland, laid in 1880, has a length of 1,423 n.m., C.R. per n.m. = 4·161 ohms, I.C. per n.m. = ·315 mfrd.

The K.R. of the German-Norwegian line would thus, by comparison with the above-mentioned cable, represent a length of 700 n.m. (1,299 km.), or about half that of the trans-Atlantic cable in question.

It was therefore natural that signalling by means of the before-mentioned system through the electrically long cable proved unsatisfactory.

A new system was tried. The main battery was increased to 70 Meidinger cells; the wiping-out battery was abandoned and replaced by graduators as a leak on the line between key and earth. The extra current from the graduators was intended to counteract the discharge, and also to serve as a weak wiping out current. By the down movement of the recorder, the coils of the relay became connected in parallel, with a resistance equal to that of the relay itself. By this arrangement the effect of the full current actuated the relay at the commencement of a signal sent through it; but as soon as the armature of the recorder touched the working contact, the current passing through the relay was halved.

However well this system might work on shorter cables, it proved inadequate for the German-Norwegian cable, unless the main battery was considerably increased. It might have been possible to improve the signalling by more sensitive cable relays; but the time had, however, arrived for abandoning the old system and adopting the double current Morse system, which is now being employed on two of the cable circuits, while the third one is being worked by means of the Wheatstone system.

The simultaneous working of Wheatstone on one circuit, and double current Morse on the two others, would have been impossible previous to 1891, especially if a fair working speed was to be got on the Wheatstone system.

The outgoing current would have produced such an amount of induction in the two other circuits, that the incoming weak current from the other station would have been affected. The incoming current in one circuit has, however, not much influence upon simultaneously incoming currents on the other circuits. The effects of induction would, in the latter case, not be felt by Arendal when that station was receiving signals on all the three circuits from Hamburg, whereas the effects from induction would be noticeable, when Arendal

* *Telegrafbladet*, Kristiania.

is sending on one, and receiving on any of the other circuits.

By the method for the elimination of induction in submarine cables, published in the Electrical Review by the chief engineer of The Great Northern Telegraph Company in Copenhagen, Mr. Dresing, and Mr. Gulstad, Arendal has succeeded in eliminating all induction, due to the outgoing current, on the cores of the German-Norwegian cable.

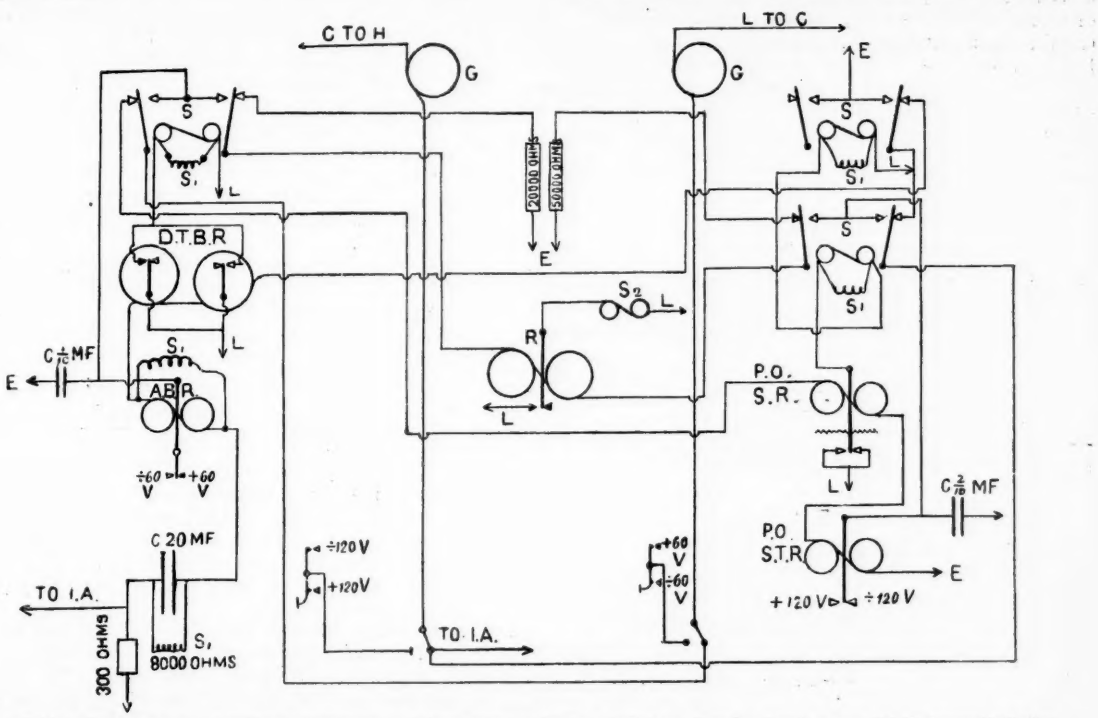
The diagram illustrates this induction system.

At the same time as key No. 1 sends a current into circuit No. 1, a current is also sent through the condenser and retardation coil to the back of the relay (connected to the shunted condenser) in circuit No. 2, on which signals are being received from Hamburg.

The resistance of the retardation coil, as well as the capacity of the shunted condenser, regulates the strength of the impulse to the relay.

By examining the diagram, it will be observed that the impulse from the condenser will pass through the relay in opposite direction of that of the current due to induction.

The values in the diagram are those used by Arendal on the German cable.



C to H, Cable to Hamburg; L to C, Landline to Christiania; G, Galvanometer; E, Earth; S, Switch; S_1, Shunt; L, Local; D T B R, Double tongued bell relay S_2, Local sounder; R, Receiver; P O S R, Post-office switch relay; C, Condenser; A B R, Allan-Brown relay; TO I A, To induction apparatus; P O S T R, Post-office standard relay.

It follows, that for the three-cored cable would be required six retardation coils with condensers and three resistance coils, between earth and the shunted condenser, and relay.

Since the above induction system was adopted last year, it has not been found necessary to make any alteration whatever in the values, and no inconvenience has been experienced from the effects of induction on the cable circuits.

The extension or continuation of the submarine cable, *i.e.*, the underground cable lines in Germany, from Hoyer to Hamburg, are all contained in the same multiple cable. As, however, it is possible to get at the cable at many points, it has been possible on the German side to overcome the induction on the three circuits in the following manner:—

The Hamburg-Arendal circuit consists of cable right through;

The Hamburg-Christiania circuit consists of 67 kilometres landline from Hamburg to Neumünster, the remainder being cable;

The Berlin-Christiania circuit consists of landline from Berlin to Flensburg. The relay at Flensburg consequently conveys the current into the cable at a point 185 kilometres from Hamburg.

As the current enters the cable at three points widely apart, no effect of induction is felt from the outgoing current on any of the circuits.

The induction is thus overcome on both the Norwegian and German side, although by employing different means for the purpose.

As the receiving medium on the cable, in connection with the Wheatstone, all the stations, with the exception of Hamburg, employ a modification of the Brown-Allan cable relay, devised by the superintendent of the Great Northern Telegraph Company's cable station in Gothenburg, Mr. Falck. The relay and most of the translators are manufactured at the Great Northern Telegraph Company's works in Copenhagen. On the Wheatstone circuit the above mentioned company's undulator is being used as receiving instrument in Hamburg, while Arendal translates by means of the Brown-Allan relay.

As switch relay on the cable side, the Great Northern Telegraph Company's double sounder relay is in use, one of the relays working the automatic switch for ÷ and the other for + current from Hamburg.

The contacts of the Brown-Allan and Standard relays are protected against "sparking" by means of condensers of 1/10 and 2/10 microfarad.

The effect of the return current from the cable is done away with by means of an extra automatic switch, which puts the cable to earth immediately after Christiania has put his key to "receive," and the current has thus no longer any influence on the P.O. switch relay, as the top switch is regulated in such a manner that it is not released until a moment after the lower switch has come to rest. It may be observed that also in this case the experience gained at the cable station in Gothenburg has been successfully employed in Arendal.

The battery power used for the cable is derived from accumulators, both at Arendal, Hamburg, and Flensburg, and is as follows:—

Hamburg-Arendal, Morse	... ...	100 volts.
Berlin-Christiania, Morse	... ...	60 „
Hamburg-Christiania, Wheatstone	...	120 „

The speed obtainable on Wheatstone is about 45 words per minute to Hamburg and about 32 to Christiania.

Experiments have been made by employing a landline from Hoyer to Hamburg, and a speed of 50 was obtained in Hamburg and 42 at Christiania.

E

A speed of 45 and 32 is, however, sufficient for a traffic of from 8 to 900 telegrams daily.

When the two Morse circuits are included, it will be seen that the cable is able to work up to 1,400 telegrams per day.

The change to the double current system (Morse on two and Wheatstone on one circuit) has therefore improved the telegraphic connection between Germany and Norway to such an extent, that the cable, by means of well regulated instruments, is now able to transmit about 2½ times more traffic than before.

INDUCTANCE OF ALTERNATING CURRENT LINES.*

As every circuit carrying current must be closed, a transmission, or other line, is simply a loop which, as in the case of the coils heretofore considered, must be filled or emptied of lines of force every time a current is set up in it or dies out. In the case of a metallic circuit, the area of the loop, of course, is the product of the length of the line by the distance apart of the wires. In the case of an earth return circuit, the effective area is, approximately, the length of the line by *twice the height* of the line above the ground.

Biot and Savart early in the history of electrical science experimentally showed that if a current flows through a long straight wire, the force that will be exerted on unit pole at a point outside the wire is numerically expressed by twice the value of the current, c, divided by the distance from the wire to the point, or

$$\text{F} = \frac{2\,c}{r}.$$

By definition, the force at any point is also measured by the density of the lines of force at that point, so that at a distance, r, from a wire carrying a current, c, the density of the lines will also be expressed by

$$\frac{2\,c}{r}$$

—of course, natural or C.G.S. units being used. Reduced to amperes and inches, this formula becomes

$$\frac{8\,\text{C}}{r}.$$

The above principle enables us to see why the distance apart of line wires affects the line inductance. Suppose, for example, we have a line current of 10 amperes; then the density of lines at a distance of 1 inch from the wire will be

$$\frac{80}{1} = 80$$

or at the rate of 80 lines per square inch; at 4 inches, 20; at 8 inches, 10; at 20 inches, 4, &c. Now, if the wires are only 4 inches apart, the area will only contain the lines of force up to a density of 80 lines per square inch, all of those beyond having no effect on the inductance as they do not cut in and out of the loop as their number changes with change of current.

In considering inductance of lines, however, what is desired to be known is the total number of lines enclosed rather than the intensity at any given point, and this is given, in lines of force per foot of wire, by the formula, $\text{N} = 15{\cdot}24 + 140{\cdot}4\,k$, where k is a value that may be found for a given case in Table I. In this table, the numbers 10, 20, &c., are

Table I.—Values of k.

$\frac{D}{d}$	k	$\frac{D}{d}$	k	$\frac{D}{k}$	k
10	1·3	50	2	120	2·38
20	1·6	60	2·08	150	2·47
30	1·77	70	2·14	180	2·55
40	1·9	80	2·2	240	2·68

the ratios of the distance apart of the wires, to the diameters of the wires. For example, the diameter (d) of a No. 1 wire B. & S., is ·3 inch and if the wires are 12 inches apart $\frac{D}{d} = 40$, and the corresponding value of k will be found in the table to be 1·9.

Now suppose we have a loop of No. 3 wire and wish to find its self inductance per foot—that is, the number of lines of force which it will contain when unit current is being carried, which number will also numerically express the E.M.F. that will be generated if this current dies out uniformly in one second.

This latter consequence is due to the fact that when the current dies out in one second, all of the lines of force will have passed out of the loop; since they all pass out in one second, and in doing so cut through the wires of the loop, an E.M.F. will be generated, expressed in the natural or C.G.S. system of units, by the number of cutting lines.

If the wires are 3 inches apart, $\frac{D}{d} = 3 \div {\cdot}3 = 10$ and $k = 1{\cdot}3$. The inductance per foot will, therefore, be $15{\cdot}24 + 140{\cdot}4 \times 1{\cdot}3 = 49{\cdot}65$ units, and therefore 197 units of inductive E.M.F. will be generated, which E.M.F. will, of course, be opposite to the line or impressed E.M.F.; if the lines are 6 inches apart this becomes 224 and 266, 308 and 376 for 12 inches, 24 inches and 6 feet, respectively. It will thus be seen that while the growth of inductance becomes smaller as the distance increases, yet the difference for lines 3½ inches and, say, 12 inches apart is quite marked.

The above formula expresses the *self*-inductance or coefficient of self-induction of a line, being based upon unit current and time, and uniform rate of cutting. If the rate of cutting is not uniform, and all of the lines are not emptied out in one second, a factor must be introduced to take account of this.

Without entering into this latter problem, the following formula is given for the inductive E.M.F. of alternating currents, of sine wave form, in which E' is the inductive E.M.F. in volts per 1,000 feet of wire, C the current in amperes, and n the frequency (twice the alternations per second), k having the same value as before:

$$\text{E}' = \frac{n\,\text{C}\,({\cdot}9575 + 8{\cdot}82\,k)}{10{,}000} \qquad (2)$$

To show the application of the formula we will apply it to two circuits:—First, a transmission line 5,000 feet long of No. 0 wire (100,000 feet of wire), over which a current of 70 amperes at 1,000 volts and a frequency of 60, is passing; and second, a circuit of the same length, but of No. 8 wire, the current being 10 amperes and of the same frequency and voltage as above.

From a wire table we find that the resistance of 10,000 feet of No. 0 wire is one ohm and that the resistance of the same length of No. 8 wire is seven ohms. The drop (C, R) in each wire is, therefore, the same or 70 volts, that is, 7 per cent. Suppose that the wires are 12 inches apart; since the diameter of No. 0 wire is ·34 inch, and that of No. 8 wire is ·165 inch, the values of $\frac{D}{d}$ for the two wires are 35 and 74, respectively. Interpolating in Table I., we find that the corresponding values of k are about 1·84 and 2·16, respectively.

Returning now to formula (2), from the above data we find the inductive drop on the No. 0 wire to be, in volts

$$\text{E}' = \frac{10 \times 60 \times 70\,({\cdot}9575 + 8{\cdot}82 \times 1{\cdot}84)}{10{,}000} =$$

72·51 volts. Similarly, the inductive drop of the No. 8 wire is 12 volts, or the two values are nearly in ratio to the current carried, that of the larger wire being somewhat less per ampere.

The combined effect on the line of the ohmic drop, or that due to the resistance of the wire, and of the inductive drop, or that due to the inductance of the wire, is not the arithmetical, but the vector, sum of these two quantities. That is, the total loss of voltage is not $\text{E}+\text{E}'$, where E is the resistance drop, but $\sqrt{\text{E}^2 + \text{E}'^2}$. In the case of the No. 0 wire, $\text{E} = 70$, $\text{E}' = 72{\cdot}51$, while for the No. 8 wire the quantities are 70 and 12, respectively. Consequently, the total effective drops in the two lines are

$$\sqrt{70^2 + 72{\cdot}51^2} \text{ and } \sqrt{70^2 + 12^2}$$

or 100·5 and 71·02, respectively.

* *American Electrician.*

It will be seen that while the inductive drop in the smaller wire is negligible, this is far from being true with respect to the No. 0 wire, the drop on which is increased from 7 per cent. to over 10 per cent. by the use of an alternating current having a frequency of 60 periods per second. As the increase of the inductive drop is proportional to the frequency, for the usual lighting periodicity of 133, the inductive drop would become 161·2 volts for the larger wire, and 26·6 volts for the smaller one; combining these quantities with the resistances as before, we have 175·7 volts and 74·8 volts. Here again, while the drop on the large wire is increased to over 17 per cent., the increase for the small wire is negligible, being less than one half of 1 per cent.

The very large increase of drop in large wires carrying alternating currents is usually ascribed to the effect of the large wire itself. As will be seen above, this is only indirectly true, the larger currents carried by such wires being the direct causes of the increase. In fact, the inductance (inductive drop divided by the current) is actually decreased with increase of size of wire.

The drop due to inductance may be decreased to any desired extent by subdividing the wires. For example, as seven No. 8 wires are about the equivalent of one No. 0, by using seven pairs of the former in parallel instead of one pair of the latter, the total line drop would be reduced to that calculated for the No. 7 wire, in which the part due to inductance is negligible. This follows from the fact that each pair of the smaller wires, if the different pairs were sufficiently separated, would be under exactly the same conditions as to inductive and ohmic drop as the single pair considered. The same effect would be produced by transposing the wires with respect to the different pairs. No reduction in drop, however, would occur by splitting only one of the wires, as in this case the conditions with respect to the cutting of lines of force would not be changed.

Of the two components of drop on alternating lines, for a given current that due to resistance will be decreased, of course, in direct proportion to any increase in the sectional area of the line, but the inductive drop will be affected to a much less extent. As an example, suppose in the case of a No. 0 wire and a periodicity of 133, we were to double the diameter of the wire, thereby reducing the resistance of the line to one-fourth ohm. The resistance drop (C R), would thus be reduced to $70 \times \frac{1}{4} = 17{\cdot}5$ volts, while from formula (2) we find that the inductive drop would become 115·7 volts. That is, by quadrupling the section of the line the resistance drop is reduced 75 per cent., while the inductive drop is only reduced 27 per cent. and still remains larger than the original resistance drop. The effective drop in this case would be $\sqrt{17{\cdot}5^2 + 115{\cdot}7^2} = 117{\cdot}1$. Thus by quadrupling the amount of copper, the effective drop is only reduced from 17·5 to 11·7 per cent., while with a continuous current the drop on the new conductors would only be $7 \div 4 = 1{\cdot}75$ per cent. It is thus evident that, when inductive drop on an alternating current line becomes appreciable, the only practicable remedy is to split the conductors.

A NEW METHOD OF DRIVING AN INDUCTION COIL.

Messrs. C. L. Norton and R. R. Lawrence, of the Rogers Laboratory of Physics, Mass. Institute of Technology, Boston, write as follows to New York *Science*:—

"Since the induction coil has come into prominence through the discovery of the X-rays of Röntgen, considerable attention has been turned toward devising some means which is applicable to long runs, on a voltage such as is furnished by electric light mains, 110 or 220 volts. The more recent forms of brake work well with storage batteries, but these are troublesome, and a brake which will work satisfactorily on the voltage of ordinary electric light mains is yet to be supplied. The following method has been devised to meet these difficulties:

"A condenser of considerable capacity is first connected to the lighting mains and charged at 220 volts. It is then disconnected and discharged through the primary coil. The charging and discharging of the condensers is effected by means of a commutator. In this way the only current passing through the coil is from the condenser. The commutator is on the shaft of a small fan motor.

"A 6-inch Ritchie coil connected in this way with a condenser of 25 microfarads, its own condenser being disconnected, gives a thick fuzzy spark about 2 inches long. Removing the primary of the coil and replacing it by about seventy turns of rather heavy wire, number 8 or 6 B. & S., we get a multitude of fine zig-zag sparks about 6 inches long, the discharge being identical in appearance with that from an induction coil worked in the ordinary manner under the best conditions. The introduction of iron, unless finely laminated, cuts down the discharge to about one-tenth its value. Increasing the speed of the charge and discharge of the condenser up to about 2,000 per minute, which is the limit of the very crude commutator at present employed, improves the discharge of the coil in quantity and voltage. The sparking on the commutator is very slight, and the amount of power taken from the mains is small.

"The discharge obtained in this way, so far as we can now judge, seems well suited for driving X-ray tubes. Tubes so driven give a brilliant fluorescent screen with strong sharp shadows. An exposure of twenty seconds gives a good photograph of the hand."

AN ELECTRIC HANSOM.

During the past year, says *Scientific American*, we have received hundreds of letters regarding horseless carriages. These letters have come from all over the civilised world. The correspondents have usually either anxiously inquired whether the automobile vehicle was in reality a practical means of transportation, or where such vehicles could be purchased.

The number of American built motor carriages which have been offered for sale has been small, and the few manufacturers who have pretended to do any business, have been somewhat reluctant to put carriages upon the market. In this respect they have been wise, and their action will only result in doing good to the motor industry. In its present state of development, the horseless carriage can hardly be trusted in the hands of those who have not some acquaintance with machinery, or those who may not be favourably disposed toward the new vehicle. The three races which have been held in America have had the effect of awakening public interest in the subject, if they have subserved no other useful purpose. If the manufacturers had greater capital at their command, the perfecting of their machines would have proceeded at a more rapid rate, but the results would probably not have been more satisfactory. We are glad to be able to chronicle the fact that for the first time in America the horseless vehicle has now entered into competition with the public cab in the City of New York.

The Electric Carriage and Wagon Company, which has offices at 66, Broadway, and a depôt where cabs may be hired at 140, West Thirty-ninth Street, has now several electric hansom cabs which will be hired at the legal rate of the public cabs. In a short time 12 of these vehicles will be at the disposal of the public, and an electric brougham will probably be added. It will be little wonder if the public does not take favourably to these handsome vehicles, which seem the perfection of the carriage maker's art.

Unlike the ordinary hansom cab, they are mounted on four wheels. To an ordinary cab body a battery box is attached, forming an extension in the rear. Upon this is situated the seat for the driver. The weight of the carriage is about 2,500 lbs., the weight of the batteries alone being from 800 to 900 lbs. The diameter of the large wheels is 43 inches, while the diameter of the small wheels is 32 inches. The wheels run on ball bearings that have tangent wire spokes, steel rims and thick pneumatic tyres. Each of the front wheels is connected with a motor of the Lundell type, of nominal 1½ horse-power. Each motor is inclosed in an iron case, and drives each wheel independently. The pinion from the armature shaft meshes with the internal gears of the wheels. The internal gears permit of turning corners with ease. The storage batteries which are used are supplied by the Electric Storage Battery Company, of Philadelphia, Pa.

They are chloride accumulators of 70 ampere-hours capacity. It is arranged so that automatic connection is made when the batteries are run into the battery container, by means of contact plates, and fuses are provided as a safeguard. The controller is situated at the left side of the driver's seat, so that it is easily manipulated with the left hand. There are three speeds forward and one speed backward. The first notch of the controller gives a speed of 5 miles per hour; the second notch, 8 to 10 miles; the third, 13 to 15 miles. Fifteen miles may be regarded as about the maximum speed which is desired or can be obtained with the hansoms. These speeds are obtained by various groupings of the batteries and motors in series and parallel.

Directly in front of the driver is a lever which controls the steering mechanism, which is extremely ingenious. The steering is accomplished by turning the rear wheels parallel with each other from a point directly over the tread of the wheel. The wheels are connected by rods to a vertical lever of a convenient height to be operated from the front seat of the carriage. In reality, the steering mechanism looks like an enormous hollow hub which turns freely, horizontally, upon the vertical rod which supports the body of the carriage. The steering mechanism enables the carriage to be turned completely around in a very short space.

A powerful roller brake adds to the safety with which the carriage can be driven, but one of the things that is remarked by persons who ride for the first time in the horseless carriage is the ease with which it may be stopped. In this respect it compares very favourably with any horse vehicle. From the driver's seat the doors of the cab are also opened and shut, and the electric light is turned on or off. An electric bell under the footboard gives warning of the approach of the almost noiseless vehicle, and when used with discretion will add very much to the safety of the carriage.

Each of the carriage lamps has an incandescent lamp, and there is also an incandescent lamp in the cab, so that the passenger can sit and read if he desires. A speaking tube runs from the interior of the cab to the driver's seat, where the mouthpiece is secured by a holder, connection being made with a flexible tube. The attention of the driver of the carriage is attracted by a whistle which is actuated by a rubber bulb in the inside of the cab. This bulb forms the mouthpiece of the speaking tube a plug being removed when conversation is to be held with the driver.

The motion of the cab is pleasant in the extreme. There is no vibration such as is often found in carriages driven by one of the petroleum products. The ease with which the electric carriage can be started and stopped, the absence of vibration and disagreeable odours, are points in its favour. The batteries afford power sufficient to propel the carriage from 18 to 25 miles on the level, depending upon the state of the road. With a private plant the batteries may be charged at an expense of from 10 to 12 cents. The cost is increased where the electricity must be purchased. It is estimated that the carriage can be run at an expense of about a cent per mile. Riding in a hansom cab of this kind is pleasurable in the extreme. There is nothing whatever to interrupt the view of the passenger.

The carriage proper was built by the Charles Caffery Company, of Camden, N.J., and the motors were built by the Interior Conduit and Insulation Company, New York City. The carriage was invented by Messrs. Morris & Salom, of Philadelphia, Pa. It will be remembered that their "Electrobat" obtained the gold metal at the Chicago *Times-Herald* race in 1895 upon the following points, to quote from the report of the judges:—"Safety, ease of control, absence of noise, vibration, heat, odour, cleanliness, and general excellence of design and workmanship." We illustrated the "Electrobat" in the *Scientific American* for November 16th, 1895. At the Providence race the "Electrobat" made five miles in 11 minutes 27 seconds, average 2·17, or at the rate of 26·2 miles per hour. The officers of the Electric Carriage and Wagon Company are Isaac L. Rice, president; W. W. Gibbs, vice-president; and the superintendent of the new depôt for horseless cabs is Edwin A. Adams.

CORRESPONDENCE.

Re Insulated Conduit.

Many good things come from America, and we are always open to learn something from our cousins over the herring pond; but in the question of wiring they must take a back seat and learn something from us. It seems, therefore, rather a waste of energy to go about beating the drum and shouting "fire" where there is none, when your own house is on fire—and we have all heard what a hard-worked man the American fireman is.

It is, perhaps, an open question, and one not yet decided by the scientists, whether the almighty dollar is not another form of energy: and that being so, we are within our rights in asking for further information before we transfer it, by the aid of gas or otherwise, into any other form. The most important question—that of cost—has not been sufficiently thrashed out. But looking at the market price of insulated conduit, it appears to be about five times as expensive as iron pipe and ten times that of casing, for the same capacity of wires. As regards labour and cost of erection, no comparison can be made, because proof cannot be given that better work or worse work is employed, and no two installations are alike. The whole question, therefore, resolves itself into whether the increased cost of material is made up for by other advantages. Take insulation. The resistance between inside and outside of these tubes is said to be 300 megohms per mile. This is presumably for a straight or continuous length. What then, I ask, is the insulation resistance of a ramified system, with joints, boxes, &c., when installed in a building? I should venture to guess nearer 300 ohms than megohms. The system, then, seems to me to be a direct encouragement to the jerry wireman to put in poor wire and rely on the insulation of his conduit. And if his conduit fail him, the insulation resistance of the whole system will be proportional to that of the quality of wire drawn in—or rather to his honesty.

The question of condensation is not important. Good

vulcanised wire will not be hurt by water, but only by frequent alternation of moisture and dryness.

As regards arcing, the accusation that bare pipes encourage this may hold only where there is a bad system of fusing; and as your article points out, this only shows ignorance of English methods. Arcing between wires of opposite polarity is also due to the same course, coupled with that of bad insulation, and the statement that the interior insulation of these tubes will withstand the arc seems to want proof. I have certainly never heard of any organic substance that will resist the heat of the arc.

It therefore seems to me that the whole question of the advantages of this system over other systems depends on the class of material and workmanship employed; and as all systems are open to the same criticism, we are brought back to the question of prime cost, when all other things are equal. Where then is the advantage of the interior insulated conduit?

V. Zingler.

Commutatorless Continuous Current Dynamo.

In last week's Electrical Review there is a somewhat involved, though rather amusing letter, under the above heading, signed by Messrs. A. De Puydt and M. Poncin. These gentlemen, one may safely conclude, must be labouring under some illusion, though exactly what the nature of this illusion may be, it is quite impossible to say.

It is not easy to see what useful purpose the letter is intended to serve, unless it be to advertise the fact that the writers are engaged in designing a commutatorless continuous current dynamo, which, besides being in all other respects perfect, will have the further advantage of working *without sparking!* It should, however, be well known that commutatorless dynamos have already been made (for electrolytic and other purposes), and that they have invariably run sparklessly. There is certainly no earthly reason why some portion of the magnetic circuit should not revolve with the armature conductors, and there is nothing novel in this idea. However, without seeing Messrs. De Puydt and Poncin's design—for somehow, though nothing is said to the contrary, one has a sort of feeling that the machine has not yet been completed and *tested*—it would be useless to discuss the question further.

But in those theoretical considerations which all other designers of dynamos have, unfortunately for them, overlooked, there is much food for thought, and we are naturally led to regret that the true meaning of the words *fulcrum* and *body* and *material point* was not made clear to us when we were young, because here Messrs. De Puydt and Poncin have the undoubted advantage of us. But with regard to the statement in electro-magnetism, upon the fallacy of which the design of the dynamo is based, it is difficult to understand why the wire, C, should not be made use of as a *fulcrum*, the only assumption being that the word is used in its popular sense. There is surely no reason why this wire should not be made of comparatively large diameter, and secured, if necessary, in a suitably insulated vice.

There is a difference in the case of the magnetic pole, P, because this is presumably of the kind known by scientists as a *free* magnetic pole, and it is quite possible that there is no fulcrum in it. But is it a *body?* This is a question which can only be dealt with by metaphysicians, and it should not be rashly answered in the affirmative, simply because we represent such a free magnetic pole by means of a black spot on paper. But if the magnetic pole, P, *is* a body, is it not possible that the medium surrounding P and C, even if it be a solid in a gaseous state, such as air, or what is commonly known as a vacuum, may be a body also?

It is not easy to express oneself clearly after reading Messrs. De Puydt and Poncin's letter; but these inventors will naturally wish to view their theory in various lights, and the above considerations are, with diffidence, put forward in the hope that they may illuminate it from a new quarter.

X. Y.

Micanite.

With reference to our letter regarding micanite insulation, which you were kind enough to publish in your issue of February 26th, we take the liberty of enclosing you herewith a copy of a letter just received from the Schenectady Railway Company, of Schenectady, N.Y., U.S.A. The contents of this letter speak for themselves; we should be glad, however, if you could find space in your valuable journal to insert this communication, and so be the medium of possibly satisfying scepticism of our critics.

Bergtheil & Young.

March 22nd, 1897.

March 22nd, 1897.

Messrs. Bergtheil & Young,
London, England.

Gentlemen,—We notice in the Electrical Review of February 12th a criticism by Mr. A. Norman, of a statement made by us in regard to micanite, which statement was published in the January 29th issue of the same journal. We can only say, in regard to this matter, that the statement as published was absolutely correct, that the armature was re-wound without anything being done to the body insulation except to shellac it thoroughly before winding, that the armature was put into service at once and has since been steadily running under one of our heavy cars and giving perfect service.

Since the letter above referred to was written, we have had another similar experience on another armature of the same kind, size, and insulation. This was in use on our snow plough, and owing to deep snow and a heavy grade the motors were compelled to do such severe work, that the wires of two opposite sections on the inside of one armature was melted together into a solid *bar* of copper. The body insulation (micanite 75 mils. thick) directly under this fused mass of copper was blackened nearly all the way through, and the mica on the surface next the wire was well burned, but the effect of the burning did *not* penetrate the entire thickness of the insulation, the portion lying against the armature body being still in good condition, and the insulation between winding and body tested into megohms. As a matter of curiosity this part of the insulation and the melted section of wire were carefully removed, and we will be pleased to show them to anyone. This one place only was re-insulated with micanite (at a cost of $200) the whole body well shellaced, and it is now being re-wound.

We think that the theory of Mr. Norman would be correct were micanite dependent for its insulating qualities on the gums which bind it together, although these gums are good insulations even up to their combustion point. Its main constituent (pine *sheet* mica, free from conducting impurities), is practically invulnerable to low voltage, say, below 1,000 volts, of direct current, even when at an almost red heat. The gums which consolidate and bind the sheet are in infinitely thin layers between the separate sheets or pieces of mica which are carefully arranged so that each piece "laps" the joint of those above and below it, thus making a long path of very high resistance even when the sheet of micanite is, as a whole, subjected to heat strong enough and long continued enough to char the *gums* all the way through. There the micanite is laid directly against metal as in an armature body, there is also the further fact that the surface against the metal will remain comparatively cooler than the portion which is being heated, mica being one of the insulating materials that is also a very fair conductor of heat. This probably accounted for the good condition of the micanite sheet next to the armature.

However, be the thing what it may, the facts and results are as given above, and have been to us a very agreeable surprise, so much so, that we thought the manufacturers should know of it. The letter was written to them entirely without their knowledge of the matter in *any* way, and the writer did not know or expect at the time that it would be so publicly used by them.

Schenectady Railway Co.
(Signed) *per* H. S. Cooper, *Superintendent.*

Jandus and Marks United.

Regarding the letters emanating from us, which have been published in your valuable journal on "Long Life Arc Lamps," we think it due to all parties interested, to inform you that the Jandus Arc Lamp and Electric Company have made arrangements, which give them the sole control of the "Pioneer" lamp patents in Great Britain.

The negotiations leading up to this has brought me into more intimate relations with Mr. L. B. Marks, M.M.E, whose letters have appeared in your publication from time to time.

And I am pleased to say, as a result of this, the points in controversy between us have been cleared up to our mutual satisfaction. From my knowledge of the subject, after years of study, I have no hesitation in stating that, in my opinion, both Mr. Marks and Mr. Jandus have each made valuable discoveries in this branch of electrical work, which ought to entitle them to be looked upon as the pioneers and elucidators of the enclosed globe arc lamp problem.

J. B. Barton,
Managing Director Jandus Arc Lamp Co, Ltd.

March 23rd, 1897.

Since writing you last an arrangement has been completed, whereby the Jandus Arc Lamp and Electric Co., Ltd., will

have sole control of the "Pioneer" lamps and the Electric Arc Light Company's rights in Great Britain.

That the public will receive the benefit of this union of interests there can be no question of doubt; a costly legal conflict has been avoided, and the enormous expenditures which had been contemplated for this litigation will now be applied to the extension of manufacturing plant. This fact, coupled with the active co-operation of the Jandus Company in Great Britain and the Electric Arc Light Company in America, will enable the consumer to obtain lamps of the very greatest perfection at the smallest possible cost.

I desire to thank you kindly for your impartial publications in relation to the "Pioneer" lamp.

L. B. Marks, M.M.E.

Chief Electrician, The Electric Arc Light Co., U.S.A.

Savoy Hotel,
March 24th, 1897.

Dynamos with Drum Armatures.

I have been reading Mr. R. Kennedy's formulæ for dynamos with drum armatures. I would feel very much obliged if Mr. R. Kennedy could give a similar simple formulæ for ring armatures.

A Subscriber.

[The formulæ are the same for ring and drum armatures, only the rule with ring armatures is to make the diameter greater than the length of the armature; this is necessary to provide space inside for the winding.

This again requires a greater number of parts in the commutator of dynamos of equal power, for we must not have many turns in each coil.

Subscriber may take $N \cdot A \cdot D^2 \cdot 0{\cdot}01$ speed peripheral 2,400, make a table beginning with an armature 6×3, going up to 6×5, speed 1,600.

Then take the 8-inch sizes, beginning with the 8 inches $\times$ 4 inches $\times$ 1,200 speed, going up to 8×8, and so on to larger diameters, never exceeding the length by the diameter.

Generally speaking, the formulæ given apply equally well to the ring armature; but the whole ground cannot again be gone over in a reply to a letter.

The commutators of ring armatures should have at least a half more sections than that of a drum armature to prevent the destructive self-induction sparking at the brushes.—R. K.]

LEGAL.

Coventry Gas Fitting Company *v.* Hughes.

Before Mr. Justice Wright at the Birmingham Assizes, an action was brought by the Coventry Gas Fitting Company against Thomas Hughes, draper, Steelhouse Lane, Birmingham, to recover £514 6s. 8d., the balance of an account alleged to be due. In October, 1895, the plaintiffs undertook to supply electric lighting for the basement and two floors of the defendant's premises, the approximate estimate being fixed at about £200. Subsequently, however, Mr. Hughes, altered his original plan so as to necessitate the lighting of an additional floor and an increase of the number of lights to be fixed from 159 to 239, and a corresponding increase of the candle-power from 4,066 to 11,950. This also required the provision of a more valuable engine and dynamo. On receiving the account, amounting to £1,100, which included some special charges for lighting during the Christmas season, the defendant denied any liability beyond the £200, the amount of the original estimate. The defence was that there was no definite contract, and his Lordship pointed out to the jury that the real question was whether the whole of the work was included in the verbal agreement between the parties, or whether a portion of it was not subsequent to that agreement.—The jury found that there was no contract for £700, and gave a verdict for the plaintiff, the amount payable by the defendant to be decided by arbitration. His Lordship certified for a special jury.

BUSINESS NOTICES, &c.

A New Electro-Chemical Company in France.—A company has just been formed at Lyons, with a capital of £120,000, to be known as the Société des Soudières Electrolytiques, procédés Leon Hulin.

"Dot" Wall Sockets.—Mr. A. P. Lundberg, writing with reference to his "Dot" two-pin wall sockets, says that on completion of a first order for 3,800, for a well-known Continental firm, he has just received a repeat order for 8,000 "Dot" wall sockets and 2,000 "Improved Pioneer" combined switch and wall sockets to take "Dot" plugs.

Electrical Wares Exported.

Week Ending Mar. 23rd, 1896.	£	s.
Adelaide	234	0
Algoa Bay	249	0
Amsterdam	40	0
Antwerp	30	0
Bombay. Teleph. mat.	34	0
Boulogne	206	0
Calcutta. Teleph. mat.	29	0
Cape Town	29	0
Constantinople. Teleg. mat.	20	0
East London	2,875	0
Freemantle	20	0
„ 245 tons teleg. poles ...		
Lorenzo Marques. Teleg. mat.	480	0
Marseilles	130	0
Melbourne. Teleg. mat.	20	0
Penang	23	0
Port Natal	170	0
Shanghai	18	0
Sydney	190	0
Tientsin. Teleg. mat. ...	140	0
Vladivostock	24	0
Total	£4,961	0

Week Ending Mar. 23rd, 1897.	£	s.
Adelaide	12	0
Amsterdam	90	0
Barcelona. Teleg. cable	359	0
Brisbane	100	0
„ Teleph. mat.	211	0
„ Iron teleph. poles	4,735	0
Calcutta	134	0
Cape Town. Teleg. mat.	160	0
Colombo	43	0
Delagoa Bay	205	0
Demerara	32	0
Durban	95	0
East London	198	0
Flushing	26	0
Fremantle	31	0
Gibraltar	10	0
Hamburg. Teleg. mat.	20	0
Malta	14	0
Mauritius. Teleg. mat.	29	0
Mossel Bay. Teleg. mat.	30	0
Odessa	35	0
Port Elizabeth	30	0
Singapore	40	0
Sydney	1,269	0
Ternenzen	22	0
Yokohama	443	0
Total	£8,373	0

Foreign Goods Transhipped.

	£	s.
Brisbane	30	0
Total	£30	0

Bankruptcy Proceedings.—The creditors of J. W. Watson, Clark & Co., manufacturers of electrical fittings and art metal workers, 23, Brooke Street, Holborn, met last Wednesday at the London Bankruptcy Court. The failure is attributed to loss in trading caused by fall in prices and competition; to law costs; and to an estimated loss of £2,500 by the forced sale of the plant, stock, and machinery. The debtors have filed accounts showing total liabilities £4,947 16s. 3d. (unsecured £881 0s. 7d.) and assets £161 2s. 2d. subject to preferential claims of £31 13s. 0d. In the absence of any offer, Mr. Carr (Oscar Berry and Carr) Chartered Accountant, Monument Yard, E.C. was appointed as Trustee to wind up the estate in bankruptcy.

Changes of Address.—Messrs. Easton, Anderson and Goolden, Limited, inform us that, having disposed of their premises in Whitehall Place, their London address, on and after March 25th, will be Broad Sanctuary Chambers, Broad Sanctuary, S.W., adjoining the Westminster Palace Hotel.

Messrs. Wilhelm & Co. inform us that they have taken larger and more suitable premises at 11 and 12, Westmorland Buildings, Aldersgate Street, E.C.

Catalogues.—We have received from Messrs. Crompton and Co., Limited, a set of illustrated price lists dealing respectively with (1) dynamos and motors for various industrial purposes, (2) arc lamps, lanterns, &c., (3) alternators, transformers and accessories, (4) electro-magnetic amperemeters and voltmeters, and electrostatic voltmeters. In (1) there are illustrated descriptions of and general information regarding Crompton dynamos and motors for electric lighting and transmission of power. Prices and tabulated details are given of dynamos for incandescent lighting, special tables of dimensions, weights, and packing charges, and useful explanatory notes being also included. Among the illustrations are photographs of Crompton multipolar generators, Crompton dynamo with Chandler engine, Crompton-Marshall dynamo working at the Prudential Assurance Company, a belt-driven dynamo of 3,000 amperes capacity, electrically driven cranes, pumps, capstans, &c. List (2) particularises in great detail the Crompton-Pochin arc lamps, hoisting gear, street lighting poles and lanterns. Photographic views show the lamps as used at Yarmouth, Edinburgh, Islington, Brighton, and Dewsbury. Holophotal projectors also are dealt with in this list; (3) contains photographic and other sketches of the Crompton-Brunton alternate current machinery.

Gas.—An unimportant correspondence has been proceeding in the *Eastbourne Gazette* on the subject, "Is gas an advantage?" "H. H." says:—" . . . . is electricity free from the element of danger? On the contrary, as a destructive agent it is far more subtle in its working than is gas." This is palpably absurd. Electrical accidents are a rarity, but not a week passes without about half a dozen gas explosions of a more or less serious character.

Gas explosions are this week recorded at Railway Hotel, Faversham, at Charing Cross Mansions, London, at Aberdeen, at Quilter Street, Columbia Road, E., and at Britannia Terrace, Northam.

An electrical engineer living at Holloway lit a match upon detecting a smell of gas, and his foolish act was followed by the usual consequences. We thought all electrical engineers were educated regarding the weak points of gas!

London Electric Omnibus Company.—This company announces that Mr. F. S. Tomkins has been appointed secretary, and that on and after Monday, the 22nd inst., the registered office of the company will be at 6, Northumberland Avenue, Charing Cross, London, W.C.

Liquidation Notices.—The Birmingham Central Tramways Company, Limited, shareholders are to meet at the offices of Messrs. Howard Smith, Slocombe & Co., 14, Waterloo Street, Birmingham, at noon, April 26th, for the purpose of hearing an account of the winding up from Mr. Smith, the liquidator.

At meetings held on March 1st and 16th at 11, Abchurch Lane, E.C., it was resolved to wind up the Foreign Pilsen Electric Light and Power Company, Limited, voluntarily, Mr. C. Oscar Webb, of the above address, being appointed liquidator. Creditors should send particulars of their debts and the usual information to Mr. Webb on or before May 18th.

At an extraordinary general meeting of the British Electrical Manufacturing and Engineering Company, held at Mullen's Hotel, Ironmonger Lane, E.C., on February 22nd, resolutions were passed winding up the company voluntarily for the purpose of entering into an agreement for the sale of the company's business and assets between the company and the Promotion and Investment Trust, Limited. Mr. Arthur Goddard was appointed liquidator, and was authorised to execute the said agreement on behalf of the company and carry it into effect, and to register a new company with a similar or identical name. An extraordinary meeting was held on March 17th at the same place, and the resolutions confirmed.

Lyons Patent Liquid Resistance.—By an arrangement made with one of the patentees, Messrs. Veritys, Limited, have acquired his right to manufacture and sell this valuable liquid resistance. Messrs. Veritys are also introducing one or two detail improvements in this apparatus, which, we understand, may be seen at their wholesale show rooms, King Street, Covent Garden.

Partnership.—Messrs. Conze & Simon inform us that they have taken into partnership Mr. Herbert Berry, who lately represented Messrs. Siemens Bros. & Co., Limited. The name of the company has been altered to Simon, Berry & Co., and all debts due to Conze & Simon will be taken over by the firm under the new style, and likewise all liabilities will be paid by the new partners. It is their intention to conduct the business upon the same lines as heretofore.

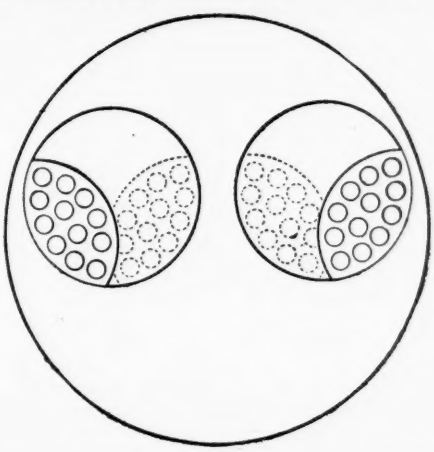
Reconstruction.—At meetings held on February 25th and March 12th, at Leonard Street, Finsbury, it was resolved to wind up Charles Churchill & Co., Limited, voluntarily, for the purposes of reconstruction. Mr. E. J. Palmer was appointed liquidator.

Reduction of Capital.—Notice is filed in the *London Gazette* to the effect that on Saturday, May 1st, a petition will be heard by Mr. Justice Stirling, for confirming a special resolution reducing the share capital of the Okonite Company, Limited, from £340,000 (17,000 preference shares of £10, and 17,000 ordinary shares of £10) to £320,000 (16,000 preference shares and 16,000 ordinary shares, each of £10). Creditors or shareholders desirous of opposing should appear for the purpose.

South Africa.—It is utterly vain to attempt to forecast a day in advance what will be the course of events in the Transvaal. From various reports coming to hand from time to time, however, it appears that this unsettled state of affairs has had very little effect upon electrical progress, which, we understand, is uninterrupted. On the Rand, in the supply of electric power to the gold mines, the Rand Central Electric Works, Limited, is finding plenty to do, and electrical engineering firms are also busy. We are informed by Mr. Alfred Bottomley, of Leeds, who represents Messrs. Swete & Baker, of Johannesburg, in this country, that his firm has within the last few weeks secured the sole concession for lighting the Agricultural Show ground, installing steam plant in the Midland Hotel and lighting the hotel throughout, and in addition has secured contracts for lighting Bullen's Buildings, Fordsburg Church, Savoy Hotel, Coronel's Buildings, and other houses and works. The anticipations in regard to the Transvaal, Cape Colony, and the Rhodesian districts, are represented as being full of hope for business in electrical engineering, and as British policy is the chief ruling influence in the two latter districts, territorial development must result in many valuable orders being sent home to British houses. But how many of our contractors are prepared to take the necessary steps to secure these orders, by appointing agents acquainted with the country, or sending one out from home to settle there?

The Royal Jubilee.—We referred in our "Notes" last week to the work that will be at hand for electrical firms making a speciality of electrical illumination fittings in connection with the approaching celebrations in the City, and in fact all over the country. Although one hears of various wonderful companies and syndicates being formed for the purpose of carrying out this and other work connected with the commemoration, there is little room for doubt that the firms most fitted to execute electric illumination contracts in a reliable manner are those who have had many years experience in that line. Many well-known firms will be on the look out for orders, and since our reference to the subject last week, we have had the efforts of two of these brought to our notice. The Edison & Swan United Electric Light Company has prepared several special designs, which can be supplied either for continuous or alternating currents. A specimen is the word "Ediswan," which is made up with about 60 crystals to each letter. The letters are about 18 inches deep, and the front is covered with plate glass. This device is 8 feet long, and nearly 2 feet deep. Messrs. Verity's, Limited, are also devoting considerable attention to artistic designs for the occasion, and we have before us a specimen sheet, which is exceedingly artistic. The designs are studded with tiny incandescent lamps, well arranged, and with the bulbs coloured in red, white and blue, colours which will appeal to the sentiment of every Britisher. Messrs. Verity's have a number of sample designs on view at King Street.

The Lancashire Boiler.—As at present constructed, it is certain the Lancashire boiler, though a great factor in the development of mechanical power, does its work at an enormous expenditure of energy, owing to a large portion of the hot gases generated at the furnaces passing to the chimney shaft before being thoroughly utilised. What this really means can only be vaguely guessed at, and its enormity realised in a scant measure, as the great sheets of flame are seen leaving the grate-bars. But how to derive the greatest benefit and obtain the highest efficiency from the escaping heat, is rather a knotty problem, and requires some little solving. Theoretically, the best type of land boiler is the tubular pattern, on account of the greater proportional heating surface it offers; but, unfortunately, this is not borne out practically. The reason is, firstly, that the length of the tubes is not in the requisite ratio to the diameter; and, secondly, that too many tubes are introduced, and the effect is the hot gases are split up into such multitudinous streams that their energy is lost as it were, and they are unable to overcome the resistance presented by the surface of so large a number of tubes. As the draught is thus retarded, sluggishness of the hot currents, and though more frequent firing may be resorted to, it is of no avail. Through these causes, the advantage derived in one direction in the construction of the tubular boiler is counterbalanced in another. It is probably the inherent defect of this class of boiler that is responsible for an innovation forming the subject of a recent patent. We refer to that taken out by J. Schofield & Co., of Oldham. From the particulars before us, we see the idea is to build a series of what are



termed short combustion chambers in the furnace flues of Lancashire and Cornish boilers. These chambers are formed by U-plates hydraulically pressed into shape, and each carrying about 12 short tubes, 4 inches diameter (internally), fitted parallel with the length of the flue, to which they are duly flanged and riveted. The chambers project to the centre of the flues from the side, right and left alternately, and the illustration above is a transverse section of the boiler beyond the furnace, showing the chambers in position. A Lancashire or double-flue boiler, 30 feet long, permits of 12 chambers being fitted into it, or more explicitly, one chamber in every flue ring, and as each is equal to 20 square feet, a boiler of this size, and so constructed, is provided with 200 super feet of additional heating surface, every foot of which is played upon by the passing flames. The projecting ends of the chambers are convex; this is done in order to retain the same circular area of the flues at the several points where the chambers are placed. By this invention, the evaporative power of a boiler is said to be increased 40 per cent., which if fully realisable, it is almost superfluous to add, will give this type of boilers a leading position. Special attention is being devoted to high pressure working for electric lighting, in order to meet the demand which has sprung up in this direction within the past two and three years. In point of cost, we are assured by the patentees that there is scarcely any difference as compared with conical pipes. We think power users should make some further inquiries from the patentees; it may probably be to their advantage to do so.

Tudor Accumulators.—Mr. A. B. Pescatore, of Manchester, informs us that owing to the numerous important orders that he has recently secured, he is now doubling his works and putting down extra plant, so as to be able to still deliver with reasonable promptitude. Among the orders at present in progress are large batteries for Glasgow and Edinburgh Corporations, for the Northampton and Llandrindod Wells electric supply stations, for the War Office, and numerous smaller batteries for private plant. The special type of plate for renewals meets with great favour, and we understand Mr. Pescatore is at present engaged gradually replacing several important batteries in London with this type of plate.

Veritys, Limited.—We hear that in view of the large increase in this company's wholesale trade in the North of England and in Scotland, extensive alterations have been made to their Manchester premises, 29, Princess Street; new offices have been taken for the staff, and the show room has been greatly improved and altered; it is now stocked with a large and varied selection of Veritys' designs of electroliers, and samples of their latest types of all kinds of electrical accessories, switch and distribution boards, &c.; the stores accommodation has also been greatly increased, and the department is under the superintendence of Mr. Alfred A. King, who has for the past two years been representing Messrs Veritys in the district.

ELECTRIC LIGHTING NOTES.

Australia.—On January 29th was inaugurated at Charters Towers, Australia, the electric light undertaking which has been put down by the Electric Light Company. Among those present were Mr. Callender (consulting engineer to the company) and Mr. Hesketh, the electrical engineer to the Queensland Government. Provision is made in the station for three dynamos, but only one is at work, it being capable of supplying 1,400 10-C.P. lamps. The applications already equal this number, so that the second dynamo is to be started in April. The boilers are Queensland made, being manufactured by Messrs. Evans, Anderson & Phelan, of Brisbane. The one at present fixed is of the multitubular Cornish type, generally known as the Jackass boiler, and has been tested to 240 lbs. steam pressure. It is being worked at half this pressure. This boiler is capable of evaporating 2,000 lbs. of water per hour as an ordinary load, which is almost twice the required evaporation for the present plant. The combined steam engine and dynamo are of the most modern type. The engine was manufactured by Messrs. Browett, Lindley & Co., and the dynamo by Messrs. Crompton & Co. The engine has cylinders 7½ and 11½ inches in diameter, and runs at 455 revolutions per minute, and is capable of developing 70 I.H.P. as a continuous working load. The dynamo is of Messrs. Crompton and Co.'s well-known design and manufacture, and develops the current at a pressure of 2,000 volts. The total power which this dynamo is capable of developing is 40 kilowatts. The mains and cables, of which 12 miles of conductors have been laid, are of a design specially selected to withstand the great variations of temperature experienced in this colony. The transformers, from which the direct supply to the premises of the consumers is made, were also manufactured by Messrs. Crompton & Co. They are fitted with the necessary means for preventing any of the high tension current leading on to the consumer's premises. There is no rental charged by the company for the meters installed on the consumer's premises.

Ayr.—The following from the report of Mr. A. J. Fuller, the newly appointed electrical engineer, on the working of the plant during the month of February, are interesting:—

"*Arc lamps.*—Of the 33 extinctions reported by the police, 11 were due to the globes tilting, 2 were due to the dash pots sticking, 4 were due to the carbon-holders failing, 16 were due to the gearing sticking. In order to get over the difficulty with the globes, I have ordered others of a new shape.

"*Meters.*—I am very pleased to report that we start the current quarter under far better conditions than I at first anticipated. The bulk of the meters have now been tested, and all faulty ones replaced by others which have been thoroughly calibrated at the works. There are still some 12 meters yet to be dealt with. In connection with the testing of these meters, I should like the sanction of the Committee to the buying of a stop-watch, recording minutes and seconds. The price of this would be 35s.

"*Station.*—All the plant inside the works has, I am glad to say, been running extremely well during the month.

"*Paralleling.*—The contractor's representatives are at present engaged in the adjustment of the two large engines."

The Secretary for Scotland has now sanctioned the borrowing of £15,000 for extensions, making a total of £40,900.

Bath.—The Council proposes borrowing £6,000 for electric lighting extensions.

Blackburn.—At a meeting of the Gas and Electricity Committee of the Corporation on Monday, the application of the users of electricity for a reduction in price was considered, and it was decided to recommend the Town Council to reduce the charges as follows:—6d. per unit for the first hour, instead of two as hitherto, and 3d. per unit for all consumed afterwards. In addition there will be a discount of 5 per cent. for early payment of accounts, the new arrangement to apply to the present quarter.

Brighton.—The accounts of the Brighton Corporation Electricity Works, of which a summary appeared in the last issue of the Electrical Review, have given great satisfaction to the ratepayers. The committee, in submitting the accounts, reported that during the year 1,633,576 units were generated; 261,820 units were supplied to public lamps, 1,127,001 to private consumers, 32,891 units used on works, leaving 231,864 units unaccounted for. The public lamps number 215 arc lamps and 564 incandescent lamps. In addition to paying £2,000 to the district fund account as a contribution in aid of the general district rate, it was decided to carry £3,000 to the reserve fund. The committee reported that they had decided to erect 31 electric lamps on the Madeira Road and Madeira Terrace, and to abolish 13 existing gas lamps under the eastern portion of the terrace. The committee had instructed the Town Clerk to write to the Board of Trade, inquiring whether they are in a position to grant the Corporation a new provisional order, with power to purchase motors and other apparatus to be sold or let on hire to customers. The manager reported that out of 141 consumers who last year did not derive any benefit from the sliding scale, no less than 74 consumed less than 25s. worth of electricity in the half-year, and in all only £41, while the mere cost of holding the plant, &c., in readiness to supply these 74 consumers was quite £224. He therefore strongly urged the committee to give the necessary month's notice to all consumers that in future a minimum charge of 30s. per annum for the electricity consumed will be made, and that in the case of arches the old terms of 12s. per quarter, which had hitherto only been applied to new tenants of arches, should be made to apply to all arches supplied with electricity, or, in other words, should be made retrospective. The committee resolved to act on these recommendations. A Councillor, in moving the adoption of the report, pointed out that the statement was a very satisfactory one indeed, and that, after paying interest on the capital and other charges, a net profit had been made of £5,880. After a discussion the report was adopted. The Lighting Committee, in a special report, stated that in consequence of the rapid increase in the demand for electricity, it would be necessary to apply to the Local Government Board for sanction to borrow further capital. The committee presented an estimate of the money which would be required to meet the demands of the undertaking on the capital account during the ensuing 12 months, the amount being £43,300. They accordingly recommended that application be made to the Local Government Board for sanction to borrow that sum for a period of 25 years. The recommendation was adopted. It was stated that applications for electric light since January were 50 per cent. more than at this time last year.

Chelsea.—A trial of electricity for street lighting is to be made by means of two lamps placed outside the Town Hall.

Chester.—The Electric Lighting Committee was last week authorised to order additional plant for the generating station at a cost of £8,530, and application is to be made for a £20,000 loan.

Douglas (I.O.M.).—The Town Council held a special meeting, on 19th inst., to go into the matter of the offers of the Electric Power Company and the Gas Company for lighting the principal thoroughfares. A committee was formed to consider the offers, and if advisable, to consult with the directors of the companies.

Edinburgh.—The Town Council on Tuesday decided, by 38 votes to 8, to create a reserve fund for the electric lighting undertaking. The fund was started with £4,050.

Grantown.—A meeting of those interested in the promotion of the electric lighting scheme was held in the Lower Public Hall last week. The secretary read a communication from Professor Kennedy, intimating that he would visit Grantown about Easter. It was elicited that about 1,000 16-candle-power lamps were likely to be required.

Glasgow.—The Glasgow Town Council has passed a resolution deciding that the administration of the electric lighting department of the Corporation shall be placed under the control of a separate general committee, instead of the Gas and Electric Lighting Committe, as at present.

Guildford.—The Board of Trade have released the deposit made by the Guildford Electric Company as a guarantee. The Town Council have given orders to the Borough Surveyor to have some of the roads repaired at the cost of the company.

Hampstead.—The Vestry, which has already installed electric arc lamps in Finchley Road, has given instructions for the same system to be adopted in High Street and Haverstock Hill, and has also requested the Lighting Committee to consider and report on the desirability of lighting the side roads of Hampstead by means of electric incandescent lamps.

We are pleased to observe that the Hampstead Vestry has again acted generously towards the relatives of a deceased employé who lost his life while engaged in the fulfilment of his duties. The expense of the funeral of the man White, who was killed by electric shock in one of the sub-stations, has been borne by the Vestry, and the immediate necessities of the widow have been relieved. At last week's Vestry meeting it was stated that steps were being taken to render such accidents impossible in the future. Already 20 out of the 24 sub-stations had been altered with that object in view.

Huddersfield.—During the month of February there was an increase of 17 consumers and of 838 lamps connected, and in the units metered an increase of 13,724, or 48 per cent.

Kingston.—The Lighting Committee has been requested to consider the desirability of lighting the streets not already lighted by electricity with incandescent gas, and to report to the Council at their next meeting.

Lambeth.—The electric lighting order was transferred to the new company last week. The Clerk has received £1,000 in respect of the expenses incurred by the Vestry in the past, and £5,000 as a deposit for the company carrying out faithfully the new order. These sums had been placed to the Vestry's credit at the London and Westminster Bank.

Liverpool.—The Lighting Committee has decided upon a general reduction in charges for the supply of electricity. Hitherto 7d. has been charged for the first 1,000 units consumed for private lighting purposes, and 4d. per 1,000 units subsequently used. The initial charge has now been reduced from 7d. to 6d., while the cost per 1,000 units for power has become 3d. in place of 4d. The Committee has issued its balance-sheet.

Littlehampton.—The whole electric light arrangements at the Rustington Convalescent Home, Littlehampton, which was opened last Saturday, have been carried out by Messrs. Drake and Gorham. They consist of two Cornish boilers, each capable of working up to 33 horse-power, and two engines each of 33 horse-power, either of which sets is capable of meeting all the requirements both of lighting and transmission of power. There is also an electrical accumulator of the D. P. Company's make, capable of supplying 172 lamps of 16 candle-power for nine hours after the engines have ceased to run. In order to obtain the greatest economy, feed water heaters have been fixed, so as to utilise the waste steam for heating the water before its passage to the boilers. The total number of lamps fixed is about 250, in addition to which about 150 lamps are furnished for driving the pumps for water supply, power transmission, and other purposes.

Leeds.—The Lamp Committee will recommend the Council to light the streets from the Great Northern Railway Station to the Public Dispensary by electricity. The streets embraced in the scheme include a portion of Wellington Street, Boar Lane, Briggate, and New Briggate. The lamps to be used will be arc lamps of 1,000 candle-power, placed 40 yards apart.

Manchester.—The Manchester Corporation finds its electric lighting undertaking assuming such enormous dimensions, that it has relegated the management of all matters connected therewith to a special electricity committee, although it already has, we understand, been getting on for a score of such committees. The Electricity Committee will consist of the following:—Aldermen Gibson, Griffin, Harwood, Higginbottom, King, Milling, and Rushworth, and Councillors Bax, Bowes, Brooks, Estcourt, Jennison, Lambert, R. Lloyd, Mainwaring, J. Phythian, Royse, and Uttley.

Mevagissey.—At the Mevagissey Electric Lighting Company's annual meeting, last week, the chairman moved the adoption of the balance-sheet, which showed a small balance to the company's credit. Dr. Grier seconded, and it was unanimously carried. The retiring director, Dr. Grier, was elected. Mr. Headley stated that increased facilities for producing revenue would be shortly provided.

Plymouth.—The Local Government Board have sanctioned the loan required for the electric lighting works, and the Town Council Committee have called for tenders, which will be submitted at an early meeting of the corporate body.

Southport.—On 16th inst., the Electricity Committee of the Corporation set on foot a canvass of various streets not already cabled, asking the tenants if they wished to have an electric supply, and, if so, how many lamps would be required.

South Shields.—A Local Government Board inquiry was held in the Town Hall, on 19th inst., in reference to the application of the Council to borrow £12,000 for carrying out a further extension of the electric lighting. The electrical engineer explained that it was proposed to carry the low tension mains over a specified district. It was stated that the immediate revenue to be derived from the expenditure of the £12,000, without the connection of a single customer, would be over £770, which would cover the interest and redemption on the capital. Mr. Jeckell informed the inspector that at the present time the number of lamps connected was 4,377, and the number applied for and waiting to be connected was 679, a total of 5,056. That was more than their present plant could deal with.

Theatre Lighting.—We understand that a complete installation and plant for about 1,000 16-C.P. lamps is being installed at the Grand Theatre, Fulham, by Messrs. Vaughan & Brown, Limited, to the specification and designs of Messrs. Owen Lucas and Pyke.

Tonbridge.—The Tonbridge Electric Lighting Order has been published. The price for current is to be 8d. per unit. The order contains the usual provisions as to area of supply and other details.

West Ham.—The Council has had the electric lighting contracts scandal, to which we have already referred, before it a good deal of late. As a Local Government Board inquiry is not to be held into the matter, Councillor Athey moved at the last meeting that Mr. Baggallay, the stipendiary magistrate, be asked to hold an inquiry. This course the Council agreed to, and it is understood that Mr. Baggallay has consented to act.

Wingate.—The ratepayers had the subject of electric lighting before them last week. The proposal is to obtain power by arrangement with the trustees of Wingate Grange Colliery. The initial cost would be £250 for posts, cables, lamps, &c., and an annual payment of £75, reckoning £2 per lamp for 35 lamps, to the coal company for current. The meeting sanctioned the expenditure of a sum not exceeding £320.

Wolverhampton.—A Local Government Board inquiry was held at the Town Hall on 18th inst., *re* the Council's application for £1,555 for electric lighting purposes—£600 for an additional transformer, and £955 for improving four existing transformers, and other plant. Mr. F. Harman Lewis, the borough electrical engineer, explained that the growth of business had necessitated the expenditure. He stated that the Corporation now had 151 consumers.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham.—The Birmingham City Tramways Bill came, on 18th inst., under the consideration of the House of Lords Committee on Standing Orders, presided over by Lord Morley. The agent for the Bill explained that the promoters had failed to get the consent of one local authority out of the whole number, viz., that of the King's Norton Rural District Council. Two short extensions ran into that district. They were quite at the end of the system, and were not in any way essential to the scheme. The promoters were still negotiating, and they hoped to be able to get their consent at a later stage. He added that the House of Commons had allowed the Bill to proceed on the understanding that, should the consent not be obtained, the portion of the Bill affecting King's Norton should be struck out. Lord Morley permitted the Bill to proceed on the same conditions.

Birmingham.—The deputation appointed to visit Continental and other towns *re* electric traction, returned at the end of last week, but nothing has been made public as to their likely recommendations, as they decline to say a word except that they are unanimous in their decision, and that they have had rather a bad time of it, and several of their number have caught severe colds, while others are not partial to the sea. Such are the hardships of a tramway deputation!

Bury and Rochdale.—At the meeting of the Bury, Rochdale, and Oldham Tramway Company on Friday last week, the chairman said that electric traction had continued to receive the watchful attention of the directors. Up to the present time it had appeared to them that the overhead, or trolley, system was the best, simplest, and most efficient. Under the Tramway Act of 1870 local authorities would, in 1902 or 1903, have the option of purchasing from the company several sections of the tramways, but it had been urged upon them from several quarters that electric traction should be introduced on one or two sections at any rate. The directors had therefore intimated to the Corporations of Bury and Rochdale and the local authorities of Wardle and Littleborough, that if they desired the electric system substituted for steam, the company would be prepared to introduce it, if suitable and reasonable arrangements could be made. The Corporation of Bury had decided that electric traction was desirable, and the directors hoped to hear further from them before long. The District Council of Wardle had accepted the proposals of the company, and the other authorities had the matter under their consideration. The chairman went on to discuss suggestions that had been made to the Rochdale Corporation, with a view to the application of the system of electricity to the Rochdale section, and its probable effect upon the company.

Coventry.—Councillor West, of the Electric Light Committee, is urging the Council to take supply current for charging the storage batteries of motor cars. The transformer plant for this purpose would be fixed in the switch room which it is proposed to have in the centre of the city, so as to be easily accessible.

Dublin and Lucan.—Mr. Robert Haire, Inspector under the Board of Works (Ireland), held an inquiry on 16th inst. in the Lucan Tramway Company's Offices, in connection with the reconstruction of the Dublin and Lucan Tramway Company's lines. It is proposed to work the lines in future by electricity instead of by steam. The scope of the inquiry was confined to the merits from an engineering point of view of the reconstructed tramway, the character of the gradients, and the curves and crossings, and any particular engineering difficulties, together with the modes of overcoming them. Mr. Shiel said that the company were now promoting an Order in Council for powers to work the line by electricity. The scheme was the overhead trolley system, practically the same as the Dublin and Dalkey tramway, except that there was only a single line, and there would be no necessity for a double line of poles. Mr. Fuller said there would be a single pole, an overhead trolley, and no span wires running across. Mr. Shiel said that by the proposed scheme the posts and wires would be for all practical purposes off the public road, as there would be a separate permanent way cut off from the road by a kerbstone; and consequently they would not interfere with the public road except at the level crossings. Mr. Fuller said the brackets attached to the posts would be of wrought iron of more or less ornamental pattern. There would be two wires, one for the upside and the other for the down side. Mr. Shiel said it was proposed to erect the power house on some site in the immediate neighbourhood of Chapelizod. Should the company secure powers to work the line by electricity in June next, they expect to have the cars running within four months from that date. The cars will be a considerable improvement upon the present pattern. They will be 32 feet in length, and will be of the double bogie pattern, with seats on the top, each car being made to carry 60 passengers. They are to be lighted with electricity inside and out, and finished in the most comfortable fashion. The electrical installation and the permanent way have been designed by Mr. H. J. Fuller, engineer to the company, and will be constructed under his superintendence.

Dover.—Mr. H. T. Haws has been appointed clerk of works during the equipment of the electric tramways at a salary of £3 per week. Mr. Hookham (now in the employ of the Corporation) is also retained to assist the Surveyor in superintending the works of the permanent way and rails contract, at a salary of £3 3s. per week. The Surveyor has submitted an estimate for the whole tramway scheme, and application is to be made to the Board of Trade for sanction to borrow £31,000.

Llandudno.—We understand from *Daily Tenders and Contracts* that the Llandudno Town Council have instructed Mr. A. H. Preece, consulting electrical engineer, to consider the question of electric tramways, with a view to providing in the plant now being designed for the Council sufficient additional power for working the tramways proposed to be laid down.

Leeds.—According to the report of a special sub-committee appointed to see what progress was being made in the laying of the electric tramways, the whole of the new cars are ready, and the motors are in an advanced state. 250 out of the 329 poles to be erected, are already in position, and satisfactory progress is being made.

Liverpool.—We understand that last week the Lord Mayor of Liverpool affixed the corporation seal to the purchase of the tramways of that city. The money paid will be over £500,000. The market value of shares is £11 10s. Shareholders will now receive £12 15s. in consideration of the lease of 18 years to run. The corporation intend to substitute electric traction for horses, and to reduce the fares from next August.

Halifax.—Notwithstanding the opposition which is expected to be made to the Halifax Corporation Tramway Bill, it is confidently expected, says the *Halifax Guardian*, that it will be passed early in the present session of Parliament. The committee hope to obtain the necessary powers about July, and arrangements are even now being made to hasten on the work as quickly as possible after the Bill is passed, in order to have the trams running early next year. It has practically been decided to use electricity as the motive power, and this will be supplied from the Corporation Electricity Works, by means of an accumulator plant, which will enable the Corporation to work the cars without in any way interfering with the public supply, and without necessitating any additional engines being put down. Messrs. Pollit & Wigzell are now engaged in constructing a large engine of the marine type with alternator similar to the one supplied last year. The workmen are putting in the bed, which will consist of about 15 tons of masonry. The engineer, Mr. Wilmshurst, is preparing a scheme for the supply of electricity to the tramways, and will be able to proceed with the work immediately the Bill is carried. We understand that the tramways are expected to remove the loss at present resulting from the working of the electricity plant, and in a short time the electricity works should be able to hand over a balance each year towards the relief of rates. It is gratifying to know that already the loss has been reduced by one half. From the end of this month the Electricity Committee are making a reduction of 1d. per unit in the charge for lighting, and of ½d. for motive power; the charges will thus be 5d. and 2½d. respectively.

The Brompton and Piccadilly Circus Railway.—The Select Committee appointed by the House of Commons to consider the merits of this Bill held sittings on the measure on Monday, Tuesday and Wednesday, Mr. Woodall presiding.—The object of the Bill is to incorporate a company for making an underground railway from Piccadilly Circus to South Kensington, subways for foot passengers, and lines of pipes for conducting electrical power from a generating station at Chelsea; to construct the railway in two separate tunnels for up and down traffic, and to work it by means of carriages moved by electricity or such other motive power (not being steam power) as the Board of Trade may sanction; to take lands, acquire easements, and underpin houses, to enter into agreement with public bodies and the Metropolitan and Metropolitan District Railway Companies, and for other purposes.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	March 18th, 1897.
Assab-Massowah	Feb. 20th, 1897 ...	...
(Telegrams are forwarded by boat.)		
Tenedos-Dardanelles ...	March 23rd, 1897 ...	...
Malta-Alexandria	March 23rd, 1897 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian lines interrupted near Khabarowka	March 16th, 1897 ...	March 18th, 1897.
Saigon-Bangkok	March 19th, 1897 ...	March 19th, 1897.

A Telegraph Ship in Collision.—In the case of the *Scotia*, which came before Mr. Justice Gorell Barnes, sitting with Trinity Masters a few days ago, the plaintiffs were the owners of the steamship *Medway*, and claimed damages for a collision between their vessel and the defendants' steamship *Scotia* on November 28th last in Blackwall Reach of the River Thames. It appears that shortly before 6.10 a.m. on that date the telegraph ship *Scotia*, of 4,667 tons gross, was swinging in Blackwall Reach, when the mast head and red lights of the *Medway* were seen about a mile distant and bearing on the port quarter of the *Scotia*. Four blasts were sounded on the *Scotia's* whistle, but the *Medway* came on at speed, and with her port side amidships struck the rudder and starboard propeller of the *Scotia*. The plaintiffs said that the *Scotia* was allowed to swing across the river at an improper time and without giving sufficient warning to vessels coming up the river. Mr. Aspinall, Q.C., and Mr. Noad appeared for the plaintiffs; Mr. Pyke, Q.C., and Mr. Lauriston Batten for the defendants. Mr. Justice Gorell Barnes, in giving judgment yesterday said that it was clear from the evidence that at the time of collision the *Scotia* was nearly athwart the river. The size of the *Scotia* would not have allowed of her swinging athwart the river in the short space of time that the plaintiffs alleged she swung in. The conclusion he had come to was that the *Medway* could have avoided running into the *Scotia*, and she must therefore be held alone to blame.

Caledonian Railway Telegraphs.—The employés of the Telegraph Department, Caledonian Railway Company, held their annual supper at Glasgow recently. Mr. Dunn, superintendent, who presided, drew attention to the enormous development of electrical appliances in connection with modern railway working. The company had now 9,450 electrical instruments on their system, and 23,500 miles of wire on their poles, compared with 412 electrical instruments and 7,500 miles of wire in 1870. There were 3,500,000 railway messages dealt with last year, compared with 360,000 in 1870, and the number of telegrams dealt with on behalf of the public last year amounted to 386,543. The wages bill last year reached £20,000.

French Pacific Cable.—From the Australian press we learn that the Postmaster-General has received a letter from Mr. Audley Coote, asking the New South Wales Government to bring his scheme of Pacific cable extension before the Pacific Cable Commission. He says that whenever the New South Wales Government desires to have the cable to New Caledonia extended to Fiji and beyond, he has full and ample powers to enter into a binding contract to lay a cable right through to America. He adds that the company that laid the New Caledonia cable has taken over the French Atlantic Cable Company, and is now incorporated with that company, and is known and registered as the Compagnie Française des Cables Télégraphiques, with a capital of 24 million francs. It is now laying an Atlantic cable from Brest to New York, a distance of 3,200 miles in one stretch. It is also coupling up the West Indies. Mr. Coote says that even if it were not now too late for the Government to do anything in the matter, it would always be open to Mr. Coote to himself bring his scheme before the Pacific Cable Conference.

Ocean Surveying.—In the *Navy and Army Illustrated*, of last week, we find an interesting account of "Ocean Depths," from the pen of Captain Alfred Carpenter, R.N. In this we are glad to find a well deserved tribute to the work done by the American Government in the examination of ocean depths. The lines of soundings executed by the United States Hydrographical Department, to ascertain the best route for a submarine cable from California to the Sandwich Islands was a most thorough piece of work, and was carried out with great promptitude.

Post Office Officials.—In the House of Commons last Friday Mr. Hanbury, in answer to Mr. Griffith-Boscawen, said it was a fact that several prominent officials of the Post Office were present at the banquet given on March 12th by the National Telephone Company. The invitation was given by the staff and not by the Telephone Company, and the course followed was that which had been the usual practice; but the question of the desirability of attending this kind of function undoubtedly required consideration.

Telephone Exchanges.—In the House of Commons on 18th inst., in reply to Mr. Provand, Mr. Hanbury said: The sum expended upon the construction of telephone exchanges is £107,000, of which about three-fourths has been spent on the exchange at Newcastle, and a large portion of the remainder in Cardiff and the neighbourhood. It is not possible to give either the amounts earned by the telephone exchanges in the hands of the Government or the amounts spent on their maintenance. The telephones and the telegraphs have the same headquarters, charges, the same offices, the same clerks, the same mechanics, the same engineering staff. And even if the accounts of the telephones could be separated, it would not be desirable to furnish information as to the details of our working to the National Telephone Company, who are in competition with the Post Office in the very districts concerned.

The Crisis in Greece.—In connection with the disturbed state of affairs in Greece, it is interesting to notice that the cable connecting Tenedos with the Dardanelles is interrupted, and that both cables from Malta to Alexandria are also broken down. In considering the gravity of the political situation it is impossible to exaggerate the seriousness of this occurrence. We have repeatedly pointed out the weakness of the present chain of telegraph communication with India and Australia, and this only affords another illustration of how little the existing system is to be depended on.

The Post Office Trunk Telephone System.—The transfer of the trunk telephone lines from the National Telephone Company to the Post Office is now completed. The last section of the country to be dealt with comprised Manchester, Liverpool, and the surrounding district. The number of trunk telephone circuits now owned and worked by the Post Office reach the large total of 881. Of these 854 are actual metallic circuits, and 27 additional channels are obtained by the "superimposing" method, by means of which a third channel can be superimposed on two complete metallic circuits existing between two points. The British trunk telephone system approximates in point of numbers of circuits to the combined magnitude of the whole of the remainder of the European systems, while the Manchester Post Office trunk telephone exchange is the largest in the World, dealing with no less than 151 trunk circuits. The total length of the wires employed in the service throughout the Kingdom reaches to close upon 50,000 miles.

Telegraph Traffic with Australia.—According to a return issued by the Postmaster-General of South Australia, the number of words cabled in the year 1896 was 2,326,984, an increase of nearly 400,000 words compared with 1895. It is instructive to note that the Cable Conference, which sat in 1893, estimated that the number of words sent in 1896 would be 1,632,224, whereas the result shows that this estimate has been exceeded by nearly 45 per cent. From this it would seem that Mr. Sandford Fleming was amply justified in the estimates, laid by him before the Conference at Ottawa, of the traffic which might be looked for over the Pacific cable which he has so steadfastly advocated.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bray.—April 5th. The Commissioners are prepared to consider tenders for an extension to the switchboard at the electricity works. See our "Official Notices."

Brighton.—April 12th. Tenders are wanted for the supply and delivery of armoured lead covered electric cables and jointing sundries. See our "Official Notices."

Bristol.—April 7th. The Electrical Committee invite tenders for the supply and erection of condensing plant, steam and exhaust piping, &c. Electrical Engineer, Mr. H. Faraday Proctor.

Cardiff.—March 29th. The Corporation invites tenders for the wiring and fitting of the Judge's Lodgings, The Walk, for electric lighting. Particulars from the electrical engineer, Town Hall.

Dundee.—March 27th. The Town Council is inviting tenders until to-morrow for the supply of a master clock, with the necessary apparatus; also the supply and fitting up of 10 public clocks with the necessary apparatus and attachments for electrically controlling same; also for providing the current to the master clock, &c. Particulars to be obtained from the borough engineer.

Edinburgh.—April 6th. In connection with the conversion of their tramways to cable traction the Corporation invites tenders for the supply of boilers, superheaters, mechanical stokers, fuel economisers, &c. Particulars from Mr. N. Colam, 1, Parliament Square, Edinburgh.

Edinburgh.—Tenders are wanted for wiring the City Observatory, Calton Hill. See our "Official Notices."

Galatz.—March 27th. The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Galatz stating that tenders are invited for the construction and working of a system of electric tramways over a length of about 13 miles of the streets in the town of Braila. The concession is for a maximum period of 35 years. Tenders to be sent to the office of the Mayor in Braila. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between 11 a.m. and 6 p.m.

Hull.—April 8th. The Electric Lighting Committee want tenders for the following in connection with the electricity supply extensions, Borough Electrical Engineer, Mr. A. S. Barnard:—Boilers, economiser, crane, engines, condensers, pumps, dynamos, transformers, switchboards, batteries, mains, &c.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Manchester.—April 5th. The Lancashire and Yorkshire Railway Company are inviting tenders for the supply of various articles during the twelve months ended April 30th, 1898, including signal and telegraph fittings; signal, telegraph and electric light wires; wire, steel tubes for boilers, &c. Particulars from the Stores Department, Osborne Street, Manchester.

Plymouth.—March 26th. Tenders have to be in to-day for the supply to the Corporation of alternators, dynamos, boilers, condensers, pumps, accumulators, cranes, switchboards, mains, conduits, transformers, arc lamps and posts, and various other apparatus and machinery in connection with the electricity works of the Borough. Borough Electrical Engineer, Mr. J. H. Rider.

Portsmouth.—April 2nd. The Corporation wants tenders for the supply and erection of three motor generators and switchboard arrangements, also a battery of accumulators with stands. Engineers, Messrs. Kincaid, Waller & Manville.

Wells.—March 27th. The Lighting Committee wants tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, &c. Particulars from Dr. John Hopkinson, 5, Victoria Street, S.W.

CLOSED.

France.—The French Post and Telegraph Authorities have just divided a contract for 122 kilometres of paper-insulated cables between Messrs. Aborlard & Co., Paris, and M. A. Grammont, of Pont-de-Cheruy (Isère).

London.—The Fire Brigade Committee brought up to the London County Council last Tuesday a recommendation to light the Clerkenwell Station by electricity. Six out of seven firms invited to tender quoted as follows, £50 being included in each case for contingencies. The Committee recommended that the tender of Messrs. Russell & Russell (the lowest) for wiring and fitting be accepted:—

	£	s.	d.
Russell & Russell	308	10	0
Private Wire & Telephone Installation Company..	336	18	5
F. A. Glover & Co.	336	10	0
Laing, Wharton, & Down, Limited	374	2	6
Pritchett & Gold	404	0	0
Rashleigh Phipps & Co.	456	0	0

London.—The Middlesex County Council has accepted the following tenders in connection with the electric lighting of the new annexe and the recreation hall of the Asylum including the stage. Specifications were prepared by Messrs. Massey & Allpress:—

	£
Electric wiring and fitting, Veritys, Ltd.	730
Two dynamos (40 unit), India-Rubber Co., Silvertown ..	430
Two 70 B.H.P. horizontal compound engines, Davey, Paxman & Co.	719 odd

NOTES.

German Hours of Work.—From a paper recently read by Mr. B. Hopps to the students I.E.E., it would appear that in a German drawing office they work from 8 a.m. to noon, take a mid-day meal hour until 3 p.m., and then resume work again until 7 p.m., the three hours mid-day break being a German characteristic, rendered necessary by heavy eating and a long rest at mid-day. Think of the possibilities that might be crowded into the mid-day three hours. We once knew some pupils in Liverpool who contrived, by hook or crook, to run a sort of consulting office between them, by a little judicious leave, and the dinner hour supplemented by evening work; but this German mid-day gap would enable one to run a foundry on the *sub rosa* principle. In the workshop the mid-day break is of two hours only, and the starting hour is 7 a.m. The typical German foreman is described in a manner to indicate him as a coarse, growling bear, though he is not so bad on further acquaintance. The writer of the paper went to Germany to serve his apprenticeship, and simply recounts some of his experiences; but in several columns is unable to say anything which would indicate whether, in doing so, he had found any real advantage, nor does he give any comparison, or means for comparison, further than that a hard worker, prepared to face hard work, might do worse than serve an apprenticeship in Germany. This is rather a lame and impotent conclusion, but really there is very little in the paper to tell anyone whether the course pursued by the writer is the best or otherwise. It is simply a brief *resumé* of some experience in the Helios works of Cologne.

New Installation at Niagara Falls.—For the first time, we believe, on a large scale, aluminium is now being used as a conductor of electricity. We learn from the *Engineering and Mining Journal* that the new plant of the Pittsburg Reduction Company at Niagara Falls, known as the Lower Works, located on the high bank of the river below the Falls, has been started. The Pittsburg Reduction Company resolved to use aluminium rods or cables instead of copper for conducting the current from the generators in the power house down in the gorge, some 200 feet below, to the plant on the top of the bank. These rods are each $\frac{3}{8}$ inch in diameter and 350 feet long from the generators to the main line in the furnace room. These main line conductors, which traverse the pot room, are from 12 to 16 inches wide and 1 inch thick, and are also of aluminium. At Niagara Falls, also, the Mathieson Alkali Company are getting to work with their new chemical plant. This consists of buildings covering two acres. The company, which, as is well known, manufactures caustic soda by the Castner process, will employ 150 men, and use 2,000 E.H.P. at its new works. It already has large plants in England and at Saltville, in Virginia. At the latter plant no water power is available. A very complete electric plant for the chemical process and for lighting is installed, Westinghouse apparatus being used.

Amalgamation.—Messrs. Drake & Gorham inform us that the Jandus Arc Lamp and Electric Company have purchased from Mr. Marks the whole of the interests and rights for the United Kingdom of the Electric Arc Light Company, U.S.A., covering the Marks and Pioneer enclosed arc lamp, and other controlling patents, and have thus settled what promised to be a long and costly litigation. The position of the Jandus Arc Lamp Company thus strengthened should be practically unassailable, and the amalgamation seems to us to have been a wise course to take. Further particulars regarding this can be seen in our Correspondence Columns.

The Influence of Certain Physiological Conditions in Photometry.—This subject was discussed by Mons. Charpentier at the recent Congress of the French Association for the Advancement of Science. His paper was an extremely interesting one, and brought out several facts which play an important part in photometry, and to which, perhaps, we do not attach sufficient importance. He states that the photo-chromatic interval, at a given point of the retina, increases with the refrangibility: that is, increases when the saturation of the colour diminishes; that is, increases from the centre to the periphery of the retina. The author has evidently studied the researches of Purkinge, and he gives curves which he has obtained by plotting the latter's results. Other matters are also discussed, all of them being of physiological interest, and having an important bearing, especially in connection with the comparison of photometric results. It is evidently in photometry that the personal equation plays a very important part, and two different people will probably obtain two different results when making an experiment. It is desirable to remember this, in case discrepancies should arise. Those of our readers who are interested in photometry should certainly obtain the original memoir, as they will find it worthy of careful study. A paper upon the same subject was also presented jointly by de Lépinay and Nicati. They also have to say much that is interesting to read, concerning the variations of the sensation to light of the retina, the phenomena of Purkinge, the variations of the eye with fatigue, and so forth. Formulæ are given in this paper, for the visual acuteness, and a good deal of light is thrown upon the part played by the eye in photometry. Several other papers, having a bearing upon the same subject, were also presented at the Congress.

Off to America.—The New York *Electrical Review* for March 17th says:—"Mr. Arthur Wright, general manager of the large Brighton, Eng., electric station, has accepted an invitation from the National Electric Light Association to read a paper at the Niagara Falls meeting. The paper will be on the subject of the profitable extensions of central stations. Mr. Henry Reason, of the Reason Manufacturing Company, and Mr. W. L. Madgen, of *Lightning*, will visit America in company with Mr. Wright, in order to attend the meeting of the National Electric Light Association."

Lord Rayleigh's Third Lecture.—In the third of his lectures on "Electricity and Electrical Vibrations," delivered at the Royal Institution last Saturday, Lord Rayleigh began by discussing the measurement of alternating currents. For this purpose, according to the *Times* report, he said the galvanometer was unsuitable, because while it was intended to measure the average current running in one direction, the average of an alternating current was mathematically zero. The galvanometer might, however, be adapted to measure alternating currents by virtue of the fact that if a needle were subjected to the influence of an induced current, it was deflected instead of remaining stationary, as it might have been expected to do, seeing that it was exposed to alternate currents of equal force in each direction. This phenomenon was explicable on the supposition of a soft iron action in the galvanometer needle, which could not consist of ideally hard steel. A needle of soft iron would be temporarily magnetised by the currents flowing in its vicinity, and hence would be deflected. Nor would this deflection be neutralised by the equality of the opposing currents, because its magnetism would also be reversed with them. Hence the effects would be cumulative. Lord Rayleigh proceeded to describe a device of his own, founded on these considerations, which he had employed during his work on argon for the measurement of alternating currents. Here, as he had shown in a previous lecture, it was necessary to take into account not only the amperes and volts, but also the lag of the current used. Of two coils placed in parallel planes, and both operating on the same soft iron needle, one carried the main current, while the two ends of the other were connected through a high resistance with the two sides of the place where the energy was being spent. By observing the different deflections of the needle according as current was allowed to flow in one or other of these coils, or in both, it was possible to calculate the angle of lag. The concluding part of the lecture dealt with alternating currents having a periodicity of from 100 up to several thousand a second, Prof. Hughes's method of studying these by means of a telephone being employed. In addition to the telephone, however, Lord Rayleigh used one of his sensitive flames, thus rendering the results visible to the whole audience. The telephone attached to a secondary circuit was placed beneath the sensitive flame, which plainly showed disturbance when current was switched on in the primary coil. One of the most interesting experiments depended on the interposition of a plate of copper between the two coils. This had the effect of almost completely quieting the flame, because the copper in the circumstances behaved approximately as a perfect conductor, thus proving Maxwell's statement that an infinitely good electrical conductor would absolutely prevent induction between the two coils, and therefore stop the sound in the telephone.

Society of Arts.—On Wednesday evening, March 24th, a paper on "The Transmission of Power by Alternating Electric Currents," was read by Mr. William B. Esson, M.Inst.C.E, M.I.E.E. The chair was taken by Mr. Alexander Siemens, M.Inst.C.E., M.I.E.E., member of the Council of the Society.

Institution of Electrical Engineers.—The next students' meeting will be held on Wednesday, March 31st, at 7.30, when a paper will be read on "Electrical Tramway Traction," by Mr. Percy S. Sheardown.

The Utilisation of Electricity in Farming.—One of the most serious attempts to utilise electrical energy in the cultivation of land, has been carried on during the last two years at Enguibaud, a village near St. Paul-Cap-de-Joux, in France, at a farm owned by Mons. F. Prat. It is true that electricity has been tried in some of the Western States of America in connection with farming, and also in Russia and Germany with varying success. It is also true that in the Press have been published various accounts which are more or less apocryphal, of installations of this kind. At Enguibaud, however, there is no doubt that a serious and genuine attempt has been made to demonstrate that electrical energy can be made of use to the farmer. The French agriculturist, like the English agriculturist, is in a very decadent condition, and if the French farmer is to compete in growing corn with the Russian, the American, or the Indian farmer, something desperate will have to be done. Experimental electrical energy in the cultivation of wheat has been carried out in order to see whether it is possible, by adopting it, to reduce the cost of putting the grain upon the market. In a recent issue of *l'Energie Electrique*, a full description is given of the installation at Enguibaud, which has been designed and carried out by Mons. P. Tailhades, of the well-known firm of Bonnet, of Toulouse. The writer wisely avoids the question of growing corn at a price which will compare favourably with the corn of foreign origin, and confines himself to describing the means whereby electricity can be employed in farming operations. He shows very clearly that given certain natural advantages, as for example a good head of water, it is possible to carry out a very large number of those operations in farming which are commonly executed by means of horse or steam power. The experiment is a plucky one, but it does not seem at all certain that Mons. Prat has lost by it; on the other hand, he has installed upon his farm power which he can control almost by a movement of the hand, and he has succeeded in saving much loss, delay and annoyance, which is always involved in the use of horse or hand power. The article is well illustrated. There are pictures showing the machinery employed, and a map of the estate, which exhibits how the power is distributed. Altogether, the experiment at Enguibaud is a useful contribution towards the solution of that much vexed problem of how to make agriculture pay.

Our New Cruisers.—The *Terrible* has made her trial trips, and her Belleville boilers have come off with flying colours. We write this with satisfaction, not because we have any great faith in the Belleville boiler for warships, but because these big cruisers seem to be necessary in these days of crazy telegrams, and little wars fomented by our professed friends. At the same time we cannot conceal from ourselves the fact that the working of the Belleville boiler seems, if we are to take the engineer's account as correct, to demand an extreme care and regularity that might be difficult to maintain just when most needed. The boilers of the *Terrible* have worked up to something more than 25,000 horse-power, and the progressive skill of the staff has so far increased, that from a coal consumption of 2·608 in the first trial of the *Powerful*, the last of *Terrible* only shows 1·71, the decrease having been progressive. We have not as we write, any figures before us to show how this last figure compares with that obtained with ordinary boilers, nor need that concern us at the moment, though it must be noted that the engines are triple-expansion and the pressure is 230 lbs., and should be expected to give good results. It is stated that when once heated half an hour is sufficient to enable full power of the engines to be worked. So far, then, all is good, and Mr. Durston, who is, we suppose, responsible for this gigantic experiment, should be well pleased with the outcome. We still think the experiment was too big, and we are still doubtful of the wisdom of it, and not less so because of the consummate skill shown in these trials. We have been told that the stoker in the navy is always hungry, and that slop tea has to serve when oatmeal would be served in the mercantile marine; that, in fact, the stoker is underfed. Now, an underfed man is not the man for a warship, and we think if the Belleville boiler is to become common, a very large reserve of men trained to its use should be got ready. We cannot hope to go to war and escape without the loss of some stokers, and we fear our fighting ships are becoming quite too complicated and scientific. Science is all well enough on a trial trip. At the trials of the *Terrible* the chief engineer was present, and several other engineers, and 40 draughtsmen, as well as the builders, and everything was of course laid out in a manner that will not be possible even on a British man-of-war at all times. The *Engineer* expresses the hope that the mind of the British taxpayer will now be calmed by the success of these new vessels and their addition to the Navy; yet our contemporary's own account of the working of the boilers is itself quite enough to give an opposite effect, so special appears to have been the whole performance. The *Engineer* claims that the Belleville boiler, though French in origin, has been made a success by English engineers. We trust this really is so.

Lecture.—At the Theatre Royal, Grantham, on 16th inst, Prof. J. A. Fleming lectured on "The Work of an Electric Current."

Personal.—We hear that Mr. Prim, the Superintendent of the Lighting and Ventilation Department of the Houses of Parliament, is shortly to retire. It was in a great measure due to Mr. Prim that the electric light was introduced into the Houses, and it has been done under his supervision.

American Accuracy.—Our contemporary, the *Electrical World*, in its leading editorial note, makes a statement which is so palpably absurd, that it is surprising to us how it could have escaped the searching editorial eye. We are told that the London Institution of Electrical Engineers has just been favoured, *for the first time in ten years*, with a presidential address. Upon turning to our contemporary's "English Notes" the cause of this error is apparent, the writer of the editorial par. having reproduced some of his remarks and missed out the last clause of a sentence which would have made it clear that Sir Henry Mance's address was the first for 10 years "dealing mainly with submarine telegraphy."

NEW COMPANIES REGISTERED.

Mavor & Coulson, Limited (3,464).—Registered in Edinburgh on March 17th with capital £28,000 divided into 5,600 shares of £5 each, to carry on the business of engineers and electricians, carried on by Mavor & Coulson, at Glasgow and elsewhere, to extend or limit the same, and to carry on the business of engineers generally in the United Kingdom. The subscribers (with one share each) are:—H. Mavor, 47, King Street, Mile End, Glasgow, engineer; W. Coulson, 47, King Street, Mile End, Glasgow, electrician; S. Mavor, 47, King Street, Mile End, Glasgow, electrician; A. Walker, 47, King Street, Mile End, Glasgow, cashier; J. Shepherd, 47, King Street, Mile End, Glasgow, engineer; G. Anderson, 47, King Street, Mile End, Glasgow, draughtsman; J. Williamson, 47, King Street, Mile End, Glasgow, foreman. The first directors shall be H. Mavor, W. Coulson, and S. Mavor; qualification £500. Registered by Oswald and Son, agents, Edinburgh. Registered office, 47, King Street, Mile End, Glasgow.

Electrical Time-Recording Company, Limited (51,695).—Registered March 16th with capital £12,000, in £1 shares, to carry on the business of electrical and mechanical engineers, and manufacturers of, and dealers in, electrical and mechanical clocks, and other time-recording instruments. The subscribers (with one share each) are: H. H. Grenfell, 18, Ashburn Place, S.W., captain R.N.; A. G. Ross, 11, Upper Phillimore Gardens, W., gentleman; W. H. Stockall, 6 and 8, Clerkenwell Road, E.C., watch and clock maker; L. G. Milne, 65, Huddleston Road, Tuffnell Park, N., correspondent; G. C. Pellinger, 39, Victoria Street, S.W., electrician; G. H. Clarke, 39, Victoria Street, S.W., accountant; H. M. Rosenberg, 39, Victoria Street, S.W., assistant. The number of directors is not to be less than two, nor more than 10; the subscribers are to appoint the first; qualification, one share; remuneration as fixed by the company. Registered by W. R. Bourke, 39, Victoria Street, S.W.

CITY NOTES.

Hull Corporation Accounts.

The accounts of the Hull Corporation record a continuous and steady progress. After providing for the interest on mortgage debentures, a sum of £1,384, and putting aside £1,466 for loan, a balance of £1,970 is carried forward. The cost of production naturally shows some improvement, and altogether the Electric Lighting Committee ought to be satisfied with the position they have achieved with the present plant.

The following table gives the cost per unit:—

	1896.	1895.
Total capital invested	—	£45,423
Number of units sold	£340,439	£246,277
Number of lamps connected	—	—
Revenue from sale of current	£7,775	£6,066
Net revenue	£4,822	—
Average price obtained per unit ...	5·7d.	5·9d.

Cost of production.	£		Per unit.	1895.
Coal	721		·51d.	·62d.
Oil, waste, water and engine room stores	155		·11d.	·11d.
Salaries and wages at generating station	991		·70d.	·62d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	710	Works' cost 1·82d.	·50d	·59d.
Rates and taxes	209		·15d.	·14d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	527		·37d.	·61d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,313		2·34d.	2·69d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	7,775	0	0	5·7d.
Meter rents	266	0	0	—
Other items	66	0	0	—
Stores	29	0	0	—
Total	£8,136	0	0	5·7d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·34d.; works' cost, 1·82d.

The Scarborough Electric Supply Company, Limited.

The accounts of this company having now been made in the Board of Trade form it is possible to examine the cost of production and compare it with last year's figures. We have already given the results of the year's working, and which showed that the profits have enabled the company to pay a dividend of 4½ per cent., and as showing the growth of the company's prosperity, it may be mentioned that while the profits in 1894 were £418, they stand at £1,713 for 1896.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£33,760	£31,293
Number of units sold	174,514	135,177
Number of lamps connected ...	—	12,788
Revenue from sale of current ...	£4,235	£3,368
Net revenue	£1,604	£937
Average price obtained per unit ...	5·8d.	6·0d.

Cost of Production.	£		Per unit.	1895.
Coal	904		1·24d.	1·66d.
Oil, waste, water, and engine room stores	70		·10d.	·12d.
Salaries and wages at generating station	772		1·06d.	1·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	349	(Works' cost 2·88d.)	·48d.	·63d.
Rent, rates and taxes	89		·12d.	·13d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	576		·79d.	·50d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£2,760		3·79d.	4·09d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	4,235	0	0	5·8d.
Meter rents	128	0	0	—
Sale of lamps	—			—
Total	£4,363	0	0	5·8d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·79d.; works' cost, 2·88d.

The Dover Electricity Supply Company.

It is hardly necessary to point out that the accounts of this company for 1896 give very different results to those set forth in the previous report. As we pointed out last year when examining the accounts which covered only a period of nine months, it was then too early to expect the company to show a favourable report; although they have not managed to reach the dividend earning stage, the present accounts are by no means unsatisfactory, and another 12 months' work ought to place the company in a fairly prosperous position, even if the contract with the Dover Corporation for the supply of electricity for tramway purposes is not so remunerative as is expected.

The directors' report is as follows:—

"As shown thereby, the capital expended during the year has been £2,644 18s. 6d., making the total to December 31st last £50,904. The directors expect that, for the lighting plant, no large addition need be made for some time to come. During the past year the working of the machinery at the station has been satisfactory; improvements in details, desirable for greater perfection and economy, having been introduced with good results. The directors are gratified to state that the service of current to consumers has been satisfactorily maintained throughout the year. The directors have to report that there has been a small loss on this, the second year of the company's working, although for a considerable period the revenue has been in excess of the expenditure. In order to reduce the interest charges appearing in the balance-sheet, the directors at the end of last year arranged for the placing of debenture stock to the amount of £25,000, bearing interest at 4½ per cent. A considerable portion of this has already been taken up at a substantial premium, which it is proposed to apply to the reduction of the preliminary expenses and suspense accounts. This operation will result in a considerable saving in interest during the current year. A new sliding scale of charges was commenced at the beginning of 1896, and under it the average income per unit sold for private lighting is slightly over 6d., a charge which, to consumers, compares very favourably with that existing in other towns, and which the directors believe has helped to bring about the marked increase in consumption. Comparing the last three quarters of 1896 with the corresponding quarters of the previous year, the increase of current sold for all purposes amounts to 168 per cent., whilst the increase in working expenses for the same period of the year amounts only to 50 per cent. The relative differences in income and working expenses will, it is confidently expected, be further marked during the present year. The equivalent number of 8-C.P. lamps connected at the end of 1895 was 4,125, which has been raised during the past year to 7,904. It is worthy of note that of the number of fresh applications, 40 per cent. were from existing consumers for extensions. It has been found that some consumers have been using very wasteful lamps, which led to dissatisfaction with the charge for current. Arrangements have consequently been made to test lamps that may be brought to the works at a nominal charge of from 1d. each. Several churches are now using or installing the light, and most of the leading hotels, including the Lord Warden, the Grand, the Metropole, and the Shakespeare, have been connected during the past year. The Burlington Hotel and the New Tivoli Theatre also propose to take a supply from our mains. The directors are glad to report that further public lighting has been entrusted to this company, nine additional lamps being on order in replacement of existing incandescent gas lights. An important step has been taken by the directors in contracting with the Dover Corporation to supply the power necessary for the tramway service to be commenced in the summer. The contract provides a minimum supply of 160,000 Board of Trade units, and it is hoped that, with the economy effected by more fully utilising the present building, and the superintending and working staff, it will yield a reasonable profit. The retiring directors are Sir W. H. Crundall and Mr. B. H. Van Tromp, who, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election."

The following table gives the cost per unit:—

	1896.	1895.
Total capital invested	£50,904	£49,268
Number of units sold	154,200	56,658
Number of lamps connected	7,904	4,125
Revenue from sale of current	£2,674	£1,004
Net revenue	—	—
Average price obtained per unit	4·14d.	4·23d.

Cost of Production.	£		Per unit.	1895.
Coal	1,041		1·62d.	2·29d.
Oil, waste, water, and engine room stores	96		·15d.	·61d.
Salaries and wages at generating station	925		1·43d.	1·83d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	175	(Works' cost 3·47d.)	·27d.	·40d.
Rent and taxes	114		·18d.	·16d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	817		1·27d.	3·51d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,168		4·92d.	8 80d.
Not included in above.				
Public lamps	126			
Total	£3,294			

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	2,674	0	0	4·14d.
Meter rents	77	0	0	—
Trading account	59	0	0	—
Pupils' premiums	13	0	0	—
Discount account	16	0	0	—
Total	£2,839	0	0	4·14d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·92d.; works' cost, 3·47d.

The third annual meeting of this company was held on Thursday, of last week, Sir William Crundall in the chair.

The Chairman, in moving the adoption of the report, said he had great pleasure in again welcoming the shareholders to this, the third meeting, over which he had had the honour of presiding. He regretted the small attendance of shareholders, but he supposed that to a certain extent that meant that the general body of shareholders were satisfied with the way in which the directors had managed the affairs of the company. The report having not only been circulated amongst the shareholders, but also to the local papers, it might be taken as read. No doubt the shareholders had carefully considered that report, and he thought that they would agree with him that they had every reason to congratulate themselves on the last year's working. It would be remembered that at the last annual meeting of the shareholders they went so far as to shadow forth that they would probably be able to pay a dividend out of the year's working. They had not quite arrived at that stage, but they were next door to it. The income practically balanced the expenditure, not taking into

account the interest payable on debentures. If they had been able to place the whole of their ordinary shares, they would not have had to pay interest on debentures, and in that case the income would have covered the expenditure, and left a small profit. Looking at the results of the working in the 21 months ended December 31st last, they had connected equivalent to 7,904 lamps of 8 candle-power. Since then, scarcely two and a half months, they had received orders and arranged for nearly 3,000 more 8 candle-power lamps, so that they had got nearly 11,000 lamps, which was within 3,000 lamps of the actual capacity of their machinery. It was an axiom with regard to electric matters, that when they had secured the orders for a certain number of lamps, the lamps which were afterwards connected yielded a very much larger profit, so that they had on that account a good prospect for the coming year. As to the price paid for current, he would say a few words. The price charged in Dover to private consumers was 6d. per Board of Trade unit, and the price charged to the Corporation for street lighting was £30 per year per arc lamp. Compared with those prices, the charge of the London Electricity Supply Company to private consumers was 8d. per Board of Trade unit, and in supplying so large a number as 300 arc lamps the charge to the Corporation of London was £26 per arc lamp, only £4 less than the Dover Company was charging for 31 lamps. The price charged in Dover to the Corporation for arc lamps was equal to 3½d. per Board of Trade unit, while in Brighton the public lamps cost 4¾d. per Board of Trade unit. There also the Corporation had to provide the lamps, whereas in Dover the company provided them free of charge. The directors had made arrangements with the Corporation of Dover for supplying the current for the tramcars, and he thought that that would be a great advantage to this company. They had not taken this contract at a large profit, but it would be a means of utilising the day staff, and would provide a day load for their machinery as well. He read in the local papers the other day an account of a meeting of the directors and shareholders of the Dover Gas Company, and he noticed that the chairman told the meeting that they had never had a more prosperous half-year in the course of their existence, and it had been said in that room that the electric light company would not injure the gas company, but on the contrary, cause a demand for more light. The gas company appeared to be satisfied, and he thought that the public would give the Dover Electric Supply Company credit for having been the means of improving the general lighting of the streets of Dover, not only by their own lamps, but by putting the gas company on their mettle to improve their lamps and also reduce their charges. For a number of years (speaking as a member of the Dover Corporation), it had been almost impossible to get the gas company to entertain a proposal for the reduction of the price of lamps, but how they had a far better light at a much less cost by means of the new incandescent gas lamps. The town should be satisfied, and he felt confident that the shareholders of the Dover Electricity Supply Company would be satisfied with the next year's work, and with the next year's report which they hoped to be able to present to them. There was just one other point; the directors were very anxious to increase the number of their customers for private lights. The company had a large number of customers who used the light in the commercial establishments of the town, but those only consumed about an average of an hour a day throughout a year, whereas the private lights would be used on an average three or four hours a day. With the new business from the tramways and with new customers for private lights, they might fairly look forward to a prosperous year. The chairman concluded by moving the adoption of the report, which was adopted.

The Oxford Electric Company, Limited.

The ordinary general meeting of the shareholders of the Oxford Electric Company, Limited, was held last Friday, Sir Henry Mance in the chair.

The Chairman said: Nearly the whole of the expenditure for buildings has been rendered necessary by the installation of the new engine and dynamo. I may mention, however, that while extending the building and putting in the necessary foundations, it has been thought advisable to complete the river wall to the end of our boundary. This will save expense when we come to lay down additional plant or enlarge the generating station, or add offices there, a step which will be necessary in a year or two to enable us to cope with the increasing demand for current. The item £702 for engines and boilers is chiefly made up by expenditure in connection with the new engine, such as, for instance, steam piping, girders, sluice valves, and driving ropes. The cost of mains is always a heavy item with any electric light company. We are constantly making small extensions in the ordinary course of business, but the expenditure of £2,533 is mainly due to the cost of the high tension cables connecting Queen Street, Brasenose College, and North Parade sub-stations. The item also includes more than £500 expended during the year in extending our low tension service system. The £2,990, under the heading "dynamos and transformers," includes the amount paid for our new 250-unit dynamo, and also the expenses in connection with additional transformers. It has been thought desirable to have spare armatures in stock to provide for any of those running becoming faulty. The cost of these is also included under this heading. The expenditure on account of electrical instruments has been chiefly for switchboards required for additional plant. The £472 expended in meters indicates very fairly the increase in the number of our customers. Passing to the revenue account, I have simply to mention that our boilers have been overhauled, and that the armatures of some of the dynamos have been rewound; this practically renders the machines as good as new, and will account for the expenditure under this head being heavier than last year. The amount received on account of current sold to private customers last year was £6,863, as compared with £5,194 received during the previous 12 months. In addition to this, there has been a considerable increase in the amount received under our public lighting contract. This has been caused by the additional number of arc lamps now in circuit. The other items are self-explanatory, and I will, with your permission, pass on to refer to a few details of work done during the year, illustrative of our progress, which I trust you will consider encouraging. The lamps connected on December 31st, 1895, numbered 15,003. The connections on December 31st, 1896, were 19,058, showing an increase of 4,045 8-candle-power lamps, or their equivalent; 225 consumers were connected to our mains at the end of 1895. At the end of 1896 we had 270, showing an increase of 45. There were the year before last 15 colleges connected. At the end of 1896 there were 16 colleges and four halls, so that there has been an increase of one college and four halls. Another satisfactory feature in the increase of business is this, that 40 of our customers last year increased the number of lamps which they had, showing that they were perfectly well satisfied with the service and the light. A new 500 horse-power engine, triple expansion surface condensing, and dynamo of 260-kilowatt capacity, has been added to the plant, which will enable us to connect to the mains 15,000 additional 8 C.P. lamps. Three new transformers have been obtained. One has been placed in the sub-station in North Parade Avenue for the supply in the north of Oxford. The second has been placed in the High Street sub-station in Brasenose College, and the third temporarily placed in the Queen Street sub-station, the intention being to remove it to its proper position in the new Municipal Buildings yard in time for the opening ceremony in May next. Seven network boxes have been put down in the streets for low tension network, making 11 in all, and this will materially facilitate the examination and testing of the mains in the future. The public lighting has been increased by 16 additional lamps, bringing the total up to 32, the candle-power of each arc lamp having been at the same time increased from 1,200 to 2,000 candles. I believe I may say that this extension of public lighting has given general satisfaction, so much so that it has been suggested that further extensions should be considered. The board have felt justified in reducing the price of current from 8d. to 7d. per Board of Trade unit. This reduction takes effect from December 25th last. Customers who pay within one month of the delivery of the account will be entitled to a discount of 2½ per cent. on the reduced price. At least two more transformers will have to be added this year, also a new boiler, which will be erected before next winter. A material change in the switching and regulating department is contemplated, which, if carried out, will enable the distribution of current to be controlled by the engineer on duty at the generating station at Osney. We shall probably make this change when increasing the capacity of our mains between Osney and the city, and the cost of these mains will be the heaviest item in our capital account for the coming year. I now come to the question of finance. We are about to issue 2,000 shares of the company to meet the capital expenditure now going on, to which reference has been made in the report. The prospectus and forms of application will be issued in the course of a day or two to every shareholder. As there is yet no Stock Exchange quotation for these shares, I think it right to inform you that during the past year transfers for between 1,000 and 2,000 shares have come before the board at prices ranging from, say, £6 to £6 5s. per share. You will thus see that we are giving the present shareholders a considerable advantage in offering these shares at a premium of 10s. only. Assuming we are not called upon to make any considerable extension of our system over and above the ordinary increase, we do not think it will be necessary to issue more shares, at any rate not for some time, as we purpose providing for any further capital which may be required in the new issue of debentures to be made in July next to replace the £25,000 of debentures now outstanding at 5 per cent. interest. The new debentures will be for a longer date, and the rate of interest will not exceed 4 per cent. When the present issue of shares is completed, application will be made to the London Stock Exchange for a quotation, and this, if successful, will no doubt add to their market value. After some further remarks, the chairman moved that the accounts and report of the directors be approved and adopted, and that a dividend for the past year at the rate of 4½ per cent. be declared.

The Mayor seconded the adoption of the report, which was unanimously agreed to.

The retiring directors, Sir Henry Mance and Mr. J. Irving Courtenay, and the auditor, Mr. W. S. Carver, were re-elected, and the proceedings terminated with a vote of thanks to the chairman.

The Metropolitan Electric Supply Company, Limited.

The report of directors states that it will be remembered that, by a resolution passed at an extraordinary general meeting, held on June 28th, 1896, the capital of the company was increased to £1,000,000 by the creation of 50,000 new shares of £10 each. 12,500 of these shares were issued on July 4th, 1896. The capital expenditure, which at the end of 1895 amounted to £675,484 3s., now shows a total of £757,035 13s. 11d., having increased during the year by the sum of £81,551 10s. 11d. It will be seen that the principal items on this account consist of new machinery, mains, and apparatus rendered necessary through the growth of the company's business. Attention is directed to the item of £4,168 18s. 3d., which mainly consists of compensations and expenses resulting from the litigation which took place in connection with the works at South Street, Manchester Square. The reinstatement of the buildings and machinery at the Sardinia Street works, rendered necessary after the fire which occurred in 1895, has been completed; but, as a portion of the original plant is still undisposed of, it has not yet been found possible to close this account, which therefore remains in suspense. In

close connection with this subject it will be noted that a serious increase appears in the revenue account under the heading of insurances, due to the high rate of premiums demanded by the insurance companies. The board have, however, been able to obtain more satisfactory rates for the present year. The gross revenue for the year amounted to £116,459 4s, against £106,447 8s. 9d. in 1895, being an increase of £10,011 15s. 3d. The fact that this increase is less than usual is wholly due to the reduced rates of charge which the board, after careful consideration, introduced early in the year. The cost of generation, which in 1895 was £52,536 14s. 11d., amounted in 1896 to £52,619 4s. 9d., or an increase of only £82 9s. 10d. The board regard these figures as satisfactory. The balance to the credit of the revenue account, before providing for depreciation, is £46,191 16s. 1d. The directors have set aside £12,000 as an addition to the depreciation account, carrying to the credit of the net revenue account (No. 5), the sum of £34,191 16s. 1d., which, with the balance brought forward from last account and other receipts, makes a total of £37,314 4s. 5d. After deducting debenture interest and other charges, and providing for the interest on the new issue of shares, there appears a balance of £17,080 12s. 2d, of which the directors have appropriated a further sum of £1,052 10s. 4d. to finally writing off the preliminary expenses account. An interim dividend of 4s. per share on the ordinary share capital was paid on October 15th, 1896, amounting to £9,980, and the directors recommend that a further dividend of 6s. per share be now paid, making a total of 10s. per share for the year, or 5 per cent. on the capital. This will absorb a further sum of £14,970, and leave a balance of £1,058 1s. 10d. to be carried forward to the next account. The number of 8-candle-power lamps supplied by the company increased during the year 1896 from 260,000 to 308,000. The present number of lamps connected is 316,000, and the applications show no signs of decrease. A report from the company's engineering director is appended, showing that the satisfactory condition of the stations, machinery and plant has been maintained. The directors have to record with the deepest regret the death of two of their valued colleagues, Sir John Pender and Admiral Sir G. H. Richards, both of whom had been members of the board from the commencement of the company. In consequence of the pressure of other engagements, Mr. J. Denison Pender and Mr. J. C. Parkinson have found it necessary to retire from the board. On account of vacancies thus created, the directors have elected Mr. James Pender, M.P., Mr. W. Harrison Cripps, one of the largest shareholders, and Mr. John Birkbeck Lubbock, of Messrs. Robarts, Lubbock & Co., to seats on the board, and have appointed Sir Eyre M. Shaw to the office of chairman. They have also appointed Mr. Frank Bailey, their late chief engineer, to a seat on the board as engineering director. In accordance with the articles of association, the following directors, viz: James Pender, Esq., M.P., Sir Eyre M. Shaw, K.C.B., and John B. Verity, Esq., retire from the board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and are eligible for re-election.

The Direct Spanish Telegraph Company, Limited.

The directors' report for the year ended December 31st, 1896, to be presented at the meeting on Tuesday, March 30th, 1897, says that the annexed accounts for the year ended December 31st, 1896, show, after providing for interest on, and redemption of, debentures, a balance to the credit of revenue of £10,818 7s. 1d. After adding the usual sum of £5,000 to the reserve fund, the balance will amount to £5,818 7s. 1d., and the directors recommend the declaration of dividends for the year 1896 of 10 per cent. on the preference shares, and 4 per cent., free of income-tax, on the ordinary shares, absorbing £5,486 4s.; half of this amount was distributed on October 1st, 1896, as an interim dividend in respect of the half-year ended June 30th, 1896. A balance of £332 3s. 1d. will remain to be carried forward to the next account. The traffic receipts show an increase of £4,564 3s. 5d. as compared with the year 1895. This increase, due to exceptional circumstances, has enabled the directors to repay to the reserve fund, as shown in the accounts, the balance of amounts taken from it in former years for revenue purposes. The reserve fund will then, including the £5,000 mentioned above, amount to £39,673 18s. 8d. The ordinary working expenses are £660 5s. 9d. in excess of those for the year 1895. The company's cables, and the landlines in connection with them, have continued in good working order throughout the year. The directors report, with extreme regret, the death of Sir John Pender, G.C.M.G., the late chairman of the company. At the invitation of the directors, the Most Hon. the Marquis of Tweeddale has joined the board to fill the vacancy so caused. The company was represented at the International Telegraph Conference held at Buda Pesth in June and July, 1896, at which some reductions of the company's rates were agreed to. The revision of the regulations and tariffs, adopted at Buda Pesth, will come into force on July 1st next. The Marquis of Tweeddale is the director retiring by rotation, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., retire, and offer themselves for re-election.

West Coast of America Telegraph Company, Limited.

An extraordinary general meeting of the West Coast of America Telegraph Company, Limited, was held on Friday at Winchester House for the purpose of considering a scheme of reconstruction. Mr. J. D. Pender presided.

The Chairman said that on December 20th last he explained the unfortunate position of the company, and also that the directors were not prepared to carry on until the last penny was gone. At the same time he told them that a scheme of reconstruction was afoot, which they would be called upon to consider. That scheme was now before them, and he believed that it would be to the interest both of the ordinary shareholders and debenture holders to accept it. The scheme was simply the outcome of a proposal from the Brazilian Submarine Telegraph Company, involving a reconstruction of this company on the following basis:—The debenture holders to receive in exchange for their present holdings an equal amount of debentures of the reconstructed company, bearing 4 per cent. interest as from January 1st last, both principal and interest being guaranteed by the Brazilian Company; the shareholders to receive one fully paid £2 10s. share in the new company for every £10 share held in the old. In order to relieve the company of its present indebtedness outside the debentures, and to provide for the more immediate requirements of the new company, an issue of 4 per cent. income bonds for £20,000 was to be taken by the Brazilian Company and others, the Brazilian Company to receive 15,000 fully paid shares of the nominal amount of £2 10s. each as consideration. He mentioned that the directors had received proxies in favour of the scheme to the extent of 15,000 shares, equal to half the capital of the company.

The resolution was adopted.

Richmond (Surrey) Electric Light and Power Company, Limited.

The third ordinary general meeting of this company was held at the offices of the company, Moorgate Court, yesterday, Mr. Frederick W. Reynolds in the chair.

The notice convening the meeting having been read by the Secretary (Mr. H. B. Renwick),

The Chairman, after referring to the report and accounts, dealt with the improved position of the company's affairs, and spoke most hopefully on the future prospects of the company,

The report was then moved for adoption by the Chairman, and seconded by Mr. Savory, and was adopted.

Mr. T. E. Savory, the retiring director, as well as the auditors, were then re-elected.

Eastbourne Electric Lighting Company, Limited.—The annual report of this company records that £3,623 were expended during the year chiefly in extending the company's mains, in the purchase of additional machinery, and in adapting and preparing the works for the additional plant which became necessary owing to the increased demand for the light. The number of units sold in 1896 amounted to 208,095 as against 175,007 in 1895, and notwithstanding the reduction in the price of current, the gross profits amounted to £3,141, out of which the shareholders, on Monday, voted a dividend at the rate of £7 10s. per cent. per annum.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, March 31st, a special settling day in the London Electrical Cab Company, Limited, 62,768 shares, Nos. 1 to 62,768; and ordered the under-mentioned securities to be quoted in the Official List:—Chelsea Electricity Supply Company, Limited: Further issue of 12,000 ordinary shares, Nos. 20,501 to 32,500. House-to-House Electric Supply Company, Limited: 10,000 ordinary shares, Nos. 101 to 10,100. Willans & Robinson, Limited, £100,000 4½ per cent. first mortgage debenture stock in lieu of the provisional certificates now quoted.

Eastern Telegraph Company, Limited.—The board announce the payment on April 14th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the preference shares of the company for the quarter ending March 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended December 31st last.

South London Electric Supply Corporation, Limited.—We beg to draw our readers attention to the prospectus of this company, which appears among our advertisement pages. The share capital is £325,000 in £5 ordinary shares. The company intends supplying the electric light and power within the parish of Lambeth. The list of subscriptions opens to-morrow and closes on Tuesday next, March 30th.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend to the shareholders, subject to final audit of the accounts, a further dividend of 8d. per share, free of income-tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended December 31st, 1896.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 21st, 1897, were £1,012; week ending March 22nd, 1896, £952; increase, £60; total receipts for half-year, 1897, £12,818; corresponding period, 1896, £11,738; increase, £1,080.

The Liverpool Overhead Railway Company. The receipts for the week ending March 21st, 1897, amounted to £1,360; corresponding week last year, £1,149; increase, £211.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 19th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,293.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, March 17th.	Closing Quotation, March 24th.	Business done during week ended March 24th, 1897. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	4 — 5	4½ — 5½	5½	4⅞
1,612,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	50 — 53	50 — 56	52½	50
2,993,560*l*	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	95 — 96	95 — 96	96	95
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8 — 8½	8 — 8½	8 5/16	...
130,660	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15½ — 15⅝	15½ — 15⅝	15 5/16	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	165 —170	165 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	10½ — 11½	10 — 11	10⅝	10⅛
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	19⅜	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	105 —108%	105 —108 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9 — 9½	8⅞ — 9¼	9 3/16	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅜	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅜	18¼
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —105	102 —105	...	...
1,397,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	17⅞ — 18¼	17⅞ — 18¼	18 3/16	18⅛
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	127 —130	127 —130	...	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
800,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	109 —112 %	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11⅜	11¼
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17⅜	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	...	24 — 25	24 — 25	24⅞	24½
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	54 — 57	56 — 58	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	7 — 7½	6⅞ — 7⅛	7⅛	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	16⅛	16 1/16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	16⅛	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6½	6⅜
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	103 —106	102 —105	104	103
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½ — 3⅝	3 — 3⅛	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	...	5 — 6	5 — 6	...	...
238,380*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
39,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	⅜ — 1½	⅜ — 1½	1⅛	...
158,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	100 —106	101—107	104	103
64,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	7½ — 8½	7½ — 8½	8½	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	6½ — 6¾	6½ — 6¾	6½	6⅜
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1½ — 2¼	1½ — 2¼	...	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	112 —116	112 —116	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113	110	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅞%	...	1 — 1¼	1 — 1¼	1 3/16	1 1/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11¼ — 11⅜	11 — 11½	...	...
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½ — 10⅛	9½ — 10⅛	...	...
60,000*l*	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	107 —112	107 —112	...	...
164,360*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	10½ — 11½	10½ — 11½	11½	10⅞
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	9 — 9½xd	9 — 9½	9 1/16	9 1/16
60,000	Do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	19 — 20	19½ — 20½	20	19⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ — 17½	16½ — 17½	17	16½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	132 —136	134⅞	133
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	11¼ — 11⅜	11½ — 12	12	11 1/16
20,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	14½ — 15	14½ — 15	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14¼ — 14⅜	14¼ — 14⅜	14⅜	14⅜
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	...	15 — 16	15½ — 16½	16⅜	15⅛
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	11 — 12	11½ — 12½	11⅜	11½
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	120 —124	120 —124	121	120
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	12 — 13 xd	12 — 13	12⅞	12⅝
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6⅞%	7½%	10½%	14 — 15	14 — 15	14⅛	14⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	5 %	7 %	9 %	12½ — 13½	13 — 14	13⅝	13½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation March 17th.	Closing Quotation. March 24th.	Business done during week ended March 24th, 1897. Highest.	Lowest
90,000	Brush Elecl. Engng. Co., Ord., 1 to 90,000	£	2½%	...	...	¾ - 1	¾ - 1	15/16	7/8
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	...	...	1¼ — 1½	1¼ - 1½	1 7/16	1¼
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	106 —110	104 —108	105½	105
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½ — 10	9½ — 10	10	9¾
207,649	Do. do. do. £6 paid	10	...	...	...	5½ — 6	5½ — 6	5¾	...
630,000	City and South London Railway	Stock	1½%	1 5/16%	1 9/16%	59 — 61	59 — 61	59¼	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	nil	...	1⅞ - 2¼	1⅞ - 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅞ — 2¼	1⅞ — 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	nil	5 %	...	1½ — 1⅝	1½ — 1⅝	1⅝	1½
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½ — 3	2⅝ - 3¼	3 1/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	nil	...	...	⅞ — 1⅛	⅞ — 1⅛	1	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	nil	...	...	⅞ - ⅞	⅞ - ⅞	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	nil	10½%	...	11 — 12	11 — 12	...	
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19 — 20	19½ - 20½	21½	20
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ - 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	107 —112xd	107 —112	...	...
58,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ - 21½	21⅜	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 —109	106 —109	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	12⅜ — 12⅞	12⅜ - 12⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16½ - 17	16⅜ - 16⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	38 — 41xd	36 — 39	38½	36
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅞ — 11⅛	10⅞ — 11⅛	11 7/16	11

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1891—1%; 1895—5%; 1896—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 7—7½.

Do. do. 7 % Preference, of £5, 9—9½.

Do. do. 4½% Debentures of £100, 109 - 111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11½—11⅝; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½ Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅜ - 1⅝.

Yorkshire House-to-House Electricity Company. £5 Ordinary Shares fully paid, 8½—8⅝. Dividend for 1896—7 %.

* From Birmingham Share List.

Bank rate of discount, 3 per cent. (February 4th 1897).

RECENT DETERMINATIONS OF THE ELECTRICAL CONDUCTIVITY OF ALUMINIUM.*

By JOSEPH W. RICHARDS and JOHN A. THOMSON.

Many and various values have been determined for the electrical conductivity of this metal. The causes have been as follows:—

(1). The impurity of the metal used. Until 1886, the best commercial aluminium rarely surpassed 98 per cent. in purity, and it was not until 1889 that commercial metal of 99 per cent. was put on the market. As will be shown later, the effect, even within these narrow limits, is to change the conductivity nearly 10 per cent.

(2). The reference of the conductivity to copper or silver as standards. In such cases, the exact purity of the copper or silver and the physical condition of these metals, whether hard or soft, must be known in order to give the comparison its proper value; but these were in most cases either unknown or neglected. Even at the present time, the absolute conductivity of pure soft copper or silver cannot be said to be fixed closer than within 1 per cent., so that figures for conductivity of aluminium, given only with reference to copper or silver, cannot, at best, have an accurate significance.

(3). Lack of an accurate standard of absolute resistance. The adoption of standard units of resistance, by international concert, and the consequent multiplication of registered copies, has made it an easy matter to use in experiments certified instruments of accurately known resistance, and thus to dispense with self-constructed units of comparison in favour of more accurate standards.

(4). Imperfect methods of measurement. Of late years, several ingenious arrangements have been devised for eliminating from the calculations of experiments the resistance of connections, always an uncertain quantity, and more refined instruments for measuring and balancing electric currents have been constructed, thus permitting of increased accuracy in results.

In the following experiments, the specimens tested were kindly furnished by the Pittsburgh Reduction Company, and were all analysed by Mr. Handy, of the Pittsburgh Testing Laboratory, so that their composition was accurately known. The conductivity is given in absolute measurement, so that no reference to any other metal as a standard can affect the results. This was rendered possible by the use of a certified standard resistance coil of 1 "International" ohm, whose possible error is not over 0·02 per cent., and by the use of the *Carey Foster* method of comparison. The metal was in wire, of 50 foot lengths, the diameter of which was

	Analysis. Aluminium.	Iron.	Copper.	Silicon.	Sodium.	Zinc.	Resistance at 0° C. of a wire, 1 meter long by 1 millimètre diameter, in ohms. Hard.	Specific resistance at 0° C., *i.e.*, resistance of 1 cubic centimètre in absolute (C.G.S.) units of resistance. Hard.	Annealed.
(1)	99 66	0·10	0 00	0 16	0·008	—	0·031245	2453 7	2432·2
(2)	99 58	0·25	0·00	0·16	0 052	—	0·03290	2584 0	2535·0
(3)	98 77	0 20	0·57	0·45	0 012	—	0·03627	2848 0	—
(4)	97·18	0 23	2·26	0·30	0·032	—	0·03590	2819·6	—
(5	94·39	0·25	3 07	0 24	0·052	1·5(	0 03583	3011 4	2984 7

measured by a micrometer and checked by weighing and determining the specific gravity. The wires were wound on wooden bobbins and immersed in oil, the temperature of which was given by a thermometer. The galvanometer used was a reflecting instrument, sufficiently delicate for all purposes. The standard coils was immersed in water, and the room was kept at a constant temperature. The bridge wire used was carefully calibrated, and all readings were taken several times. Two separate wires were tested in case of specimen 1, the result given being

* *Franklin Institute Journal.*

the mean of two results, which differed only $\frac{1}{100}$th of 1 per cent. from each other.

For the reduction from the working temperature to 0° C. an experiment was made with wire No. (1), which showed that between 27° C. and 0° C. its temperature coefficient was 0·00392 per degree. This coefficient was used for the nearly pure wires, while for (4) and (5) a slightly lower coefficient, determined by Mr. Scott, was used. It appears that the purer the metal the greater its temperature coefficient.

Conductivity tests of a similar set of wires were made by Mr. C. F. Scott, electrician of the Westinghouse Electric Company, Pittsburgh. They were made by comparison with pure copper with a Wheatstone bridge. These results can only be compared with ours by assuming a certain value for the conductivity of copper, and even then we cannot say how nearly the copper used by Mr. Scott would approach that standard. Sir W. Thompson's value for the specific resistance of copper is 1,580, Dewar's 1,562. In the following table we reduce our results to each of these standards, and add Scott's results for comparison :—

Relative Conductivity (Copper = 100)

	Richards and Thomson. Using for copper the resistances (1,580)	(1,562)	C. F. Scott. Actual resistance of copper employed not known.
(1) Soft	65·0	64·2	—
(1) Hard	64·4	63·7	63·1
(2) Soft	62·3	61·6	—
(2) Hard	61·1	60·5	62 2
(3) Hard	55·5	54·9	56 2
(4) Hard	56·0	55·4	58·5
(5) Soft	52·9	52·3	—
(5) Hard	52 5	51 9	55 0

Temperature Coefficient for 1° C.

	C. F. Scott. (Between 15° and 80° C.)	Richards and Thomson. (Between 0° and 27° C.)
(1)	·00385	·00392
(2)	·00385	—
(3)	·00360	—
(4)	·00361	—
(5)	·00359	—

In connection with the results of Mr. Scott and ourselves, we may mention for comparison those of Charpentier-Page, who used what he calls *pure* aluminium, which may safely be assumed to be the No. 1 grade of European aluminium, averaging 99 per cent. pure. He finds as follows :—

	Specific resistance. (Calculated to 0° C.)	Compared with copper. (1,580) Per cent.	(1,562) Per cent.
Soft	2,659	59·4	58·8
Hard	2,684	58·9	58·2

It should be noticed that these results fall exactly between our Nos. 2 and 3, also just where its composition would most probably lie. The results also agree closely with ours in showing almost exactly 1 per cent. greater conductivity for the annealed than for the hard-drawn wire.

Dewar and Fleming have also recently found as the specific resistance of "Swiss aluminium about 99 per cent. pure" the value 2,563 at 0° C., which is 60·9 per cent. of that of copper, according to their own measurements. This also fits in well with our determinations, but the comparison would have been much more satisfactory if the exact composition of their metal had been determined.

C. K. McGee determined, in 1890, the conductivity of aluminium analysing 98·52 per cent. pure to be 54·8 per cent. that of copper, when unannealed. This metal was nearly identical with our No. 3 in composition, and the results are the same within 1 per cent.

The conclusions we would draw from these experiments and comparisons are that—

The conductivity of hard-drawn commercial aluminium is strongly affected by impurities, being, approximately :

	(Copper = 100.)
98 5 per cent. pure aluminium	55·0
99 0 " " " "	59 0
99·5 " " " "	61·0
99·75 " " " "	63·0—64·0
100·0 " " " " probably ...	66·0—67 0

Annealed wire has a conductivity very nearly 1 per cent. greater than the unannealed.

Lehigh University,
January 19th, 1897.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

On Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895. By H. Benest, Assoc. M.Inst, C.E, Associate. (Read March 11th, 1897.)

(*Continued from page* 406.)

The work of paying out cable from the recovered end was successfully performed at a speed of from 5 to 6 knots per hour. A dense haze over the land in the early morning disappointed expectations in a looked-for guide—the Cape Verde light. The morning observations were not reliable either, and the cable distance had to be taken for determining the distance run. The Fernando end was buoyed in 200 fathoms when 47·28 N.M. had been payed out, and ship, by dead reckoning, should have been within a mile of the line of the St. Louis-Yof coast cable, to which connection had to be made.

However, noon observations—latitude 15° N., longitude 17° 30′ 7″ W.—placed the ship 2 miles to the westward of this line. Grappling for the coast cable was started in the afternoon, and continued until the evening of the 24th, when, having made six drags and broken up some grapnels, the cable was hooked, only to lose it while heaving it up. Soon afterwards it was hooked again and raised; the bight being cut, the loose south end buoyed, and the St. Louis portion picked up for 4 miles, when the ship was headed towards buoy on Fernando end, paying out cable. At 8 a.m. the Fernando end was on board. Joint and splice were made, and the bight of the cable lowered to the bottom by a buoy rope, and the end buoyed so as to facilitate the raising of the bight again.

By the use of this portion of the coast cable the circuit between Pernambuco and St. Louis was now continuous, and the *Dacia* was set on for Dakar, to make sure of communication being perfectly restored, and to ship stores sent out from home.

On the 25th the ship arrived there, and received a satisfactory report from St. Louis as to the working of the improvised line of cable between that point and Pernambuco.

Not being able to ship stores, on account of Custom House formalities, instructions were sent through the Government landline to St. Louis to look out for signals on the broken part of the cable on the 27th, and the ship immediately left for the grappling ground.

Position 15° 1′ N. and 18° 4′ W. was reached by forenoon on 26th, the cable on the loose piece towards the break being then taken up. On testing this cable, the length to the break was found to be 35 knots. Recovery of cable was at once started, and continued until the 27th, when the cable parted near the dynamometer under a strain of 7½ tons, after all means to break it out of the ground had been tried. About 3 knots had been picked up under a strain of between 4 to 5 tons, and four hours' time was occupied in the recovery of this short length.

The ship was now set on for a position in 15° 50′ N. latitude and 17° 11′ W. longitude, to grapple the other portion of the cable from the landing at St. Louis.

On the 28th the ship was found, by morning observations, to be 8 miles north of position required. A mark buoy was soon placed near the line of cable, and preparations were made for grappling, which, however, was not found practicable, on account of strong north-east wind and a heavy swell.

Early on the 29th the grapnel was lowered, and a drag made to the south and eastward. All day was occupied in grappling, but without result. Wind increasing and sea again becoming too heavy, grappling was out of the question. Several soundings now taken across the supposed line of cable showed that the ship had been grappling to the eastward of, and had not actually crossed, the line of cable; the soundings now obtained not agreeing with the known depths shown on the chart near this locality, the soundings now taken being respectively 714, 641, 589, 552, and 492 fathoms. The position of the 641 fathoms sounding, as afterwards determined, was 1¼ miles to the eastward of the actual line of cable, and the sounding of 492 fathoms 4 miles to the eastward of it. At the position where the mark buoy was placed on the supposed line of cable a depth of 575 fathoms was found, and this proved to be 3¼ miles to the eastward of the actual line, which was equal to the error of chronometer as subsequently determined.

On May 1st, there being no signs of the weather moderating, an attempt was made to steam up towards St. Louis, but the ship rolled to such an extent in the high beam sea that the idea was given up, and the ship was kept away for Dakar, where she arrived on the following day.

On May 4th a start was again made, after having got fresh rates of corrections for the chronometers, the standard having been 13 seconds in error, or 3¼ miles—due, no doubt, to the violent oscillations caused by heavy rolling of the ship.

On arriving at the scene of operations, the weather showed signs of improvement, and grappling was resumed, with good hopes of success.

On the 5th the cable was hooked, and up to the bows at daylight. On cutting the bight and testing towards St. Louis, the cable between the ship and that point was found electrically perfect. The St. Louis end was then buoyed, and picking up on the loose piece towards the break proceeded with. The strain being high—from 4 to 5 tons—it was necessary to work the gear at low speed.

It was May 7th before the broken end was reached, 78·5 N.M. having been recovered. Quite 2½ hours were spent in getting in the last mile. Like the other side of the break, for a distance of 3 miles it was a tussle to break the cable out from the bed of mud and detritus that evidently covered it and held it fast; the most careful manœuvring being required. Patience was at last rewarded, and by

dint of coaxing and handling the ship it gradually broke away—literally foot by foot—until, with a jumping strain of from 2 to 5 and 6 tons, it finally cleared itself. The end when it was hove on board showed evidence of some severe mauling: the sheathing was squeezed flat, and the core protruded in several places.

Extract from Log, May 7th, 1895, *South American Repairs.*—4.25 *p.m.*—"Fault passed off drum. The fault shows that some hard substance had pressed against the bight of cable with a force greater than the breaking strain of cable, forcing the core out on the opposite side of sheathing for about 12 inches and breaking it; probably a large rock borne down on the cable by a mass of mud moving at a right angle or part of a right angle to the cable. Cut fault out = 3 fathoms.

"4.31 *p.m.*—Resumed picking up; cable coming in much strained, and entirely stripped of serving.

"4.42 *p.m.*—End of cable came in board bearing evidence of having been caught round a rock and broken by heavy strain. *All wires and core broken off flush. Cut half a fathom off cable.*"

A sounding taken immediately on the spot disclosed a depth of 1,574 fathoms, green mud, when 1,300 to 1,400 fathoms might have been expected. It may be here remarked that on examining the dried specimen some time afterwards, it was found to have changed colour, and upon a preliminary microscopical inspection, it showed a broken up, fragmentary deposit of sand, diatomaciæ, and globigerinæ.

Now that the ground was cleared, all cable recovered, and a length amply sufficient spliced up for running out, the next thing to be done was to join and splice up this cable on board to the main South American cable buoyed off St. Louis, and pay out south to the position of the temporary junction between the cable from Fernando and the St. Louis portion of the St. Louis-Yof Bay coast cable.

On Thursday, May 9th, a lull in the usually fresh breeze, and a diminution of the heavy swell, permitted ship to be taken up to the buoy on the cable end, and in due course the cable was got on board.

Electrical tests on this portion now disclosed a fault towards St. Louis, but not pronounced enough to localise with sufficient exactitude by tests from the ship only. To pick up towards St. Louis would have been inconvenient; so as the position of the fault was uncertain, and the weather continued to improve, it was decided to join up this end with cable in tank, and pay out south, localising the fault afterwards. To this end it was proposed by the chief electrician, Mr. J. Rymer Jones (after laying cable to position), to get the bight of the other cable up and cut it, using the portion of the St. Louis-Yof coast cable to St. Louis as one side of a loop, while the portion of the St. Louis-Fernando cable just laid served as the other half. Loop tests would then be carried out on board to localise the fault in the St. Louis end of the South American cable, and Fernando would afterwards be joined through to St. Louis as before.

The work of splicing, slipping cable from forward aft, and paying out towards position of buoy on the bight south was carried out successfully; but, as wind and sea had again increased during the day, it was found impracticable to approach the buoy, so ship was steered close past it to about one mile south, and the cable just laid from the St. Louis end buoyed at 7.30 p.m.

Early in the morning of Friday, May 10th, this buoy was picked up, the cable raised, and two miles of it hove in and coiled down in main tank. Then the ship was steamed towards the buoy on the bight, paying out cable. On reaching the buoy it was picked up, the bight of cable raised and taken on board, cut, and testing proceeded with to localise the fault in the St. Louis portion, after five hours' work in getting the cables clear, as they crossed and re-crossed at the bow, and a fresh breeze with some sea and swell obtaining the while.

The cable was now joined up through the same circuit as before, after an interruption of telegraphic communication of under four hours, the bight being again lowered to the bottom with a wire buoy rope, and buoyed.

The *Dacia* arrived at Dakar that night—11th. On the following morning an electrician, with a jointer and three cable hands, were despatched to St. Louis by rail to cut out fault on beach, should it be get-at-able, and put in a piece of new cable.

Meanwhile, the superintendent at St. Louis was instructed, through the Government telegraph line from Dakar, to make a first cut at 12 feet seaward of cable hut, and then test; then, if fault should be still in the cable, to cut again further seaward at high water-mark, and test again to the sealed end. Results of the loop tests on the St. Louis portion of the main cable located the fault on the beach near the cable house, which was afterwards proved to be the case.

Instructions were now wired to St. Louis to commence watch upon the St. Louis-Fernando cable to the sealed end at 10 a.m. on Tuesday, May 14th.

While *en route* for this position, the ship was detained for the purpose of making good the Yof (Cape Verde) end of the coast cable, a portion of which was found to be badly worn. This portion was taken out, and, the ground being cleared, ship was then set on for the aforesaid end of the St. Louis-Fernando cable proper. This end being taken up, about a mile of it was hove in, and the ship then headed for the buoy on the bight of the (*pro tem.*) St. Louis-Fernando cable, paying out cable from the bow. The buoy was reached and slipped just before darkness set in; the bight was raised, taken in board, cut, and Fernando called, but, owing to some misconception of orders transmitted through Pernambuco, over an hour elapsed before Fernando answered the call. Tests were then carried out, and, cable being found perfect electrically, the joint was at once started between the two portions of the St. Louis-Fernando cable. The splice was finished about midnight, and the bight slipped at 1 a.m. on May 15th, 1895, thus completing a very interesting, if arduous, piece of work.

The length of the St. Louis-Fernando Noronha section, on the completion of this, the second repair, shows a decrease of slightly more than 10¼ miles; the length of the section after the repair of 1893 being ... ... 1,728·67 N.M.

After repair of 1895	1,718·40	„
Decrease in length	10·27	„

The length of cable recovered during repair of 1895—

On Fernando side of break	33·004	N.M.
On St. Louis „ „	79·209	„
Total	112·213	„
Recovered cable relaid	56·37	N.M.
New cable laid	47·27	„
Total cable laid and relaid in repair ...	103·64	„

The electrical conditions of the cable as a whole, according to careful and repeated tests in each direction, may be considered unaltered, and its mechanical state sound.

A somewhat detailed account of the cable operations has been given, as many members present may not, perhaps, be familiar with the method of carrying out work of this nature on board a cable steamer.

Mention has been made of yellow fogs. This is a very curious phenomenon, coating the ship and rigging in a few hours with a fine impalpable dust. One way to collect this dust is to cut the fibres from outside the manila ropes and extract the sand from these.

But a better plan, as suggested by Mr. Warren, would be to use a clean glass, or ebonite tray, smeared with glycerine, wash out the deposit with distilled water into a bottle and seal it up.

A description of this atmospheric dust is given by the late Prof. Charles Darwin, F.R.S., in his book "The Voyage of H.M.S. *Beagle* round the World," which the writer hopes to add to the interest of this subject by repeating.

It was while the *Beagle* was in the neighbourhood of the Cape de Verde Islands. Prof. Darwin says:—

"Generally the atmosphere is hazy, and this is caused by the falling of impalpably fine dust.

"The morning before we anchored at Porto Praya, I collected some of this brown coloured fine dust, which appeared to have been filtered from the wind by the gauze of the vane at the mast-head.

"Prof. Ehrenberg finds that this dust consists in great part of infusoria with silicious shields, and of the silicious tissue of plants. In five packets which I sent him he has ascertained no less than 60 organic forms. The infusoria, with the exception of two marine species, are all inhabitants of fresh water. I have found no less than 15 different accounts of dust having fallen on vessels when far out in the Atlantic. From the direction of the wind whenever it has fallen, and from its having always fallen during those months when the harmattan is known to raise clouds of dust high into the atmosphere, we may feel sure that it all comes from Africa. It is, however, a very singular fact that, although Prof. Ehrenberg knows many species of infusoria peculiar to Africa, he finds none of these in the dust which I sent him; on the other hand, he finds in it two species which hitherto he knows as living only in South America. The dust falls in such quantities as to dirty everything on board, and to hurt peoples' eyes; vessels even have run on shore owing to the obscurity of the atmosphere. It has often fallen on ships when several hundred, and even more than a thousand miles from the coast of Africa, and at points 1,600 miles distant in a north and south direction. In some dust which was collected on a vessel 300 miles from the land, I was much surprised to find particles of stone above the thousandth of an inch square mixed with finer matter. After this fact one need not be surprised at the diffusion of the far lighter and smaller sporules of the cryptogamic plants."

The results of a recent microscopic examination at Silvertown by Mr. Warren of some of this fog dust collected on board the *Dacia*, prove that particles of some mineral substance nearly the thirtieth of an inch square are present. Some slides that Mr. Chapman, F.R.M.S., has kindly examined are, he says, of much interest, and consist mainly of volcanic dust, with traces of diatoms, chiefly fresh-water.

Slide A.—Sponge-spicules; olivine (?), felspar, and pumice fragments.

Slide B.—Spore-like bodies, spherical, pale brown, sometimes with a darker cortex, often broken; sponge-spicules: augite, olivine, felspar, pumice.

Slide C.—Quartz, felspar, augite.

Slide D.—Quartz, hornblende.

Side E.—Fragments of diatom frustules, chiefly of fresh-water species, as *Surinella bifrons.*

Taking a general survey of the soundings over the entire area covered by the repairs, it will be seen that the bottom gradients are easy.

At the position of the break of 1893, in 1,220 fathoms, all the soundings around, with one exception, show a gradual descent towards it. From the S.S.W. the grade is about 1 in 21—an approximate angle of slope of 2° 50′. From the south-eastward the grade is about 1 in 7—an approximate angle of slope of 8°; this is the sharpest slope met with. From the eastward towards the 1,220-fathom spot the grade is about 1 in 8½—an approximate angle of slope of 7°. The exception is between the depth of 1,280 fathoms and the position of the break, where the slope is reversed, showing a grade of about 1 in 17—an approximate angle of 3° 30′; but this is only a slight dip in the huge furrow which may be conceived to exist here. This furrow, or depression, in the ocean floor is shown in the contour lines of the chart now before you.

At the position of the break of 1895, in 1,574 fathoms, the gradients of the sea bottom sloping towards it from the S.W. round by S., and S.E. to N., do not in any one case exceed 1 in 26—an approximate angle of slope of 2° 30′. The slope of the nearest profile line, A to B, is but 1 in 34—an approximate angle of 1° 30′.

While picking up the cable towards the break during both repairs of 1893 and 1895, when within 2 to 3 miles of the end on either side, the strain indicated on the dynamometer increased from 2 to 5, and to 6 tons. It is therefore only natural to suppose that the cable was embedded upon each side of the furrow.

Considering the very slight grades, comparatively speaking, generally obtaining over the ground, it might be presumed that, whatever the disturbing influences might be, they would be purely local. If this be so, it is remarkable that similar conditions were met with, and that a violent destructive effect should occur at two spots some 17 miles distant, with a difference in depth of from 200 to 300 fathoms, and coinciding approximately with the direction of a profile line from the coast.

Following the contour lines towards Cape Verde, clear evidence is shown of the gully formation, with a depth of over 700 fathoms at the mouth of it. The actual depth from a flying sounding taken while paying out the St. Louis portion of the main cable, was 675 fathoms in latitude 15° 11′ N., longitude 17° 27′ W.

The depth nearer in to the coast is shown to be 531 fathoms. To the N. by W. of this position is a sounding showing 112 fathoms at a distance of 1¾ miles, and at 1 mile S S.E. a depth of 115 fathoms.

If the profile line from A to B be prolonged right away to the coast, it will be seen that it will nearly cut these soundings of 675 fathoms and 531 fathoms.

It may therefore be said that this gully formation extends to within a few miles of the shore; but judging by the period—over 12 years—during which the coast cable has lain across here in 700 fathoms in perfect safety, the diverted course of the South American cable being now alongside it, it would appear probable that these two cables may be lying upon a ledge above, and overhanging a possible submarine river outlet, so that it might be conceived that a vast mass of mud and detritus from this source may flow, however slowly, along a time-worn furrow on the sea bottom.

A dotted line is to be noted on the chart which may be taken to indicate a probable channel way, or submarine ditch, that may be imagined at some remote period to have been grooved out by the constant action of a rush of water from a river outlet. This outlet may have been submarine or at sea level, in connection with the lagoons situate as shown, which in turn were connected with a great inland river. The Admiralty charts, and those of the French Depôt Général de la Marine, give indications in support of such a supposition.

A very remarkable phenomenon, strongly favouring the theory that a submarine river outfall now exists, was witnessed during the afternoon of April 23rd, 1895, while grappling for the coast cable, in position latitude 15° 0′ N., longitude 17° 31′ W., 13 miles from the coast.

The ship was gradually surrounded by great quantities of vegetable growth, having the appearance of river weed—a whitish worm-like weed, the roots of which were similar to some that had been met with previously on a soft mud bottom to the south-westward of the Guadalquiver River. There were also birds' feathers, pieces of orange peel, whole and broken gourds, scraps of carpet, pieces of driftwood, small branches, &c.; and the colour of the sea had changed to a dirty brownish green, indicative of the presence of fresh (river) water. On the following morning all this had disappeared, and the sea had regained its usual tint of a pale green.

The nearest river outlet is that of the Senegal, 75 miles to the north-east from this position, and it would appear most unlikely that such flotsam as pieces of carpet could have been carried by the coast current, which sets to the S.S.W., to so great a distance.

No recurrence of this phenomenon took place during the four weeks that were spent in carrying out cable work in the neighbourhood; nor had such a thing been noticed before, so far as records go.

If the coast current had brought these masses of weed and refuse of human habitation out of the Senegal River, it would have been a more or less constant and familiar appearance, as would also the colour of the water; but the discoloration of the sea surface, with the accompaniment above described, would appear to be due to a sudden outburst somewhere in the vicinity, below sea level.

While upon the subject of submarine gullies, and of the probability of their formation by river outlets, whether at or below sea level, it may be mentioned that many subterranean rivers are supposed, with good reason, to exist. These have their outlets in some cases in the form of artesian wells.

Off Pescadores Point, on the coast of Peru, and off the Rovuma River, on the East Coast of Africa, similar conditions have been met with in repairs to cables. At the latter place much trouble had been experienced with the cable between Mozambique and Zanzibar, and the conclusion arrived at was that the cause was fresh water making its way to the surface of the bottom, disturbing the level and fracturing the cable.

Immense masses of mud are in continual movement off the Congo River, and extend to some hundreds of miles to the westward; but here is a very deep river debouching right into the sea, and scouring out a channel hundreds of fathoms in depth.

The West African Telegraph Company's cable between Loanda and the island of Sao Thomé has been broken seven or eight times since its laying in 1886, and some hundreds of miles of cable have been used in repairs.

Some valuable remarks upon these and other gully formations may be seen in Mr. E. March Webb's Report upon the Congo Repairs in 1887, printed and bound in book form, a copy of which will be found in the Institution library. An extract from an article on "Land Slopes separating Continents, and Ocean Basins," which appeared in the *Scottish Geographical Magazine* for May, 1887, by Mr. J. Y. Buchanan, F.R.S., is quoted by Mr. Webb, and as this refers to the Guinea coast, it will contribute to the interest of this paper to repeat it here:—

"Along the Guinea coast as far as Caps St. Paul, the 100-fathom line is at an average distance of 15 miles from the shore; and on the south-west coast, between the Niger and the Congo, it is from 30 to 40 miles from the shore. At these localities there are remarkable exceptions. Off Grand Bassam the 100-fathom line approaches within a quarter of a mile of the shore, and the curving in shorewards of the contour lines produces the very remarkable submarine gully known by the name of the 'Bottomless Pit.' From the *Buccaneer* five lines of soundings were run across it at distances of 2 miles between the lines. At 1 mile from the shore the width of the gully is under a mile, with a depth of 150 fathoms; at 8 miles from the shore its width is 1½ miles, with a maximum observed depth of 327 fathoms; while 2 miles further seaward its width has increased to 4 miles, with a maximum observed depth of 452 fathoms. The accompanying sketch plan of the contour lines gives a better idea of this extraordinary feature than can be conveyed by description. The bottom consisted everywhere of a soft dark-coloured mud, and the slopes of the sides averaged in many places 2,000 feet per mile."

The writer has been favoured with the views of the President on this subject, which Sir Henry Mance will doubtless give to the meeting himself. The illustration before you is an enlargement of his rough sketch, which explains itself. I hope that the president will pardon me for quoting some of his words, but they are so singularly *àpropos* it would be a pity not to. He says: "Now, without giving these submarine fresh-water streams the dignity of calling them rivers, we may easily imagine (in fact, we know to a certainty they exist) streams of water making their way for many miles out to sea before breaking ground."

(To be continued.)

MULTIPHASE INDUCTION MOTORS.

By A. C. EBORALL, A.I.E.E.

Up to the present time the great merits possessed by multiphase motors do not seem to have been properly recognised in this country. There are two probable reasons for this—firstly, that the demand for electrical power is very small, and secondly, that in England this type of motor has never had a practical trial, and consequently not had a chance of showing its good qualities. The fact also that the whole idea of multiphase working is of foreign origin and development undoubtedly operates to its disadvantage.

In the following paper, the author proposes to treat the multiphase induction motor from a practical point of view, discussing the general principles underlying its construction and operation, and hopes to be able to show that these motors possess to a very great extent the properties which a good motor of any kind must necessarily have.

For convenience in the treatment of the subject the paper will be divided into sections, in order that the action, construction, and running of these motors may be the better considered.

1.—The Rotary Field.

The principle of the "rotary field" (upon which all induction motors depend) may be shortly stated as follows:—

"If the currents produced by two or more E.M.Fs. displaced in phase from one another be sent round the inducing system of a motor whose rotating part consists of short-circuited coils, a rotary movement will be imparted to it." Consider for a moment fig. 1, which

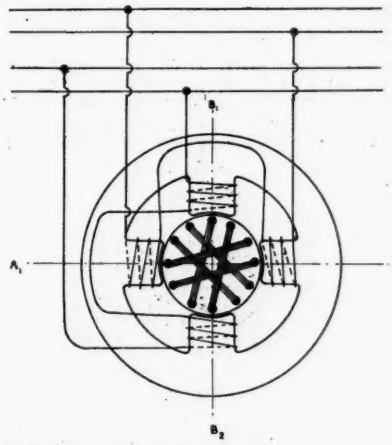


Fig. 1.

represents the elements of a two-phase two-pole motor. For the sake of clearness, throughout the paper the terms "rotor" and "stator" will be used to designate the rotating and stationary parts of a motor respectively, it being necessary to depart from the usual

"armature" and "fields," because in multiphase motor work these terms do not apply. The two former terms also have the advantage of being already in use in at least one large continental works.

Here, in fig. 1, the rotor is simply a laminated iron cylinder wound with three sets of short-circuited coils, these being wound in perforations in the iron. The stator is a laminated iron structure wound with two sets of coils, A_1, A_2, B_1, B_2, at right angles to one another. These coils receive the two-phase current from the line, that is, an alternating current of a certain frequency traverses one set of coils, and a second current of the same frequency, but differing 90° in phase, traverses the second set. If following sine functions, the two currents may be represented as shown in fig. 2. Suppose, now, that the current in coils A_1, A_2, is at its maximum value. It will produce a

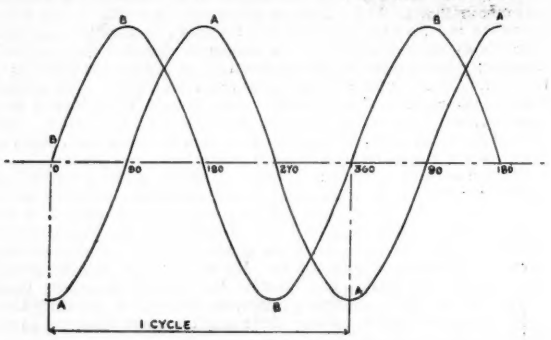


Fig. 2.

magnetic field across the ring from A_1 to A_2. At this instant the magnetising effect of coils B_1, B_2, is *nil*, as the current in them is 90° behind the current in coils A_1, A_2. As the current in these latter dies down, that in B_1, B_2, rises, until at 45° from the starting point the magnetising effect of each set will be equal, and the magnetic field has shifted forward to a position midway between A_1, A_2, and B_1, B_2. At 90°, the current in coils A_1, A_2, will be zero, and their magnetising effect nothing, while that of coils, B_1 B_2, has attained its full value, and the field has moved, therefore, to the direction of B_1 B_2. By similar reasoning, it is easy to see that the field will be in the direction A_2 A_1 at 180°, B_2 B_1 at 270°, and at 360°, or at the end of a complete cycle, will be in its first direction of A_1 A_2. Hence the field will have made one complete revolution in one cycle.

Now the effect of this rotating magnetic field on the short circuited coils of the rotor is to induce currents in them, which produce a second rotating field of their own, and this latter is always trying to catch up the field produced by the stator windings. It never quite comes up with it, but has a certain amount of "slip," this slip being the difference between the speeds of the two fields. If the speeds are taken in revolutions per second, the slip becomes identical with the frequency of the currents in the rotor windings. It is a minimum when the motor is running light, as the only load on the motor is that due to the electrical and mechanical losses. As the motor is loaded, the slip increases, with a corresponding drop in the speed of rotation of the motor. The frequency of the induced rotor currents being thus increased, they become increased in amount, and then act in regard to the stator just as the secondary currents of a transformer behave to the primary—they tend to wipe out the self-induction of the stator coils, and so allow more current to flow in response to the increase of load.

Of course, in a motor running light, if there were no losses of any kind due to hysteresis, eddy currents, resistance, and friction, the motor would be synchronous, there would be no slip, and hence no induced rotor currents, because no lines would be cut, and the motor would require no power to drive it. The full load slip in a modern motor of good design and average size never exceeds 5 per cent., unless designed for special work.

In the particular case shown in fig. 1, the speed of the rotating field is identical with the frequency of supply—thus if this latter was 50 ~ the field would rotate 50 times a second, or 3,000 times a minute, and the speed of the motor running light would be a little less. The speed of rotation of the rotating field is always inversely

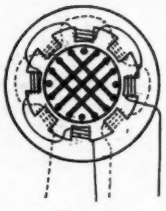


Fig. 3.

proportional to the number of pairs of stator poles per phase, and directly proportional to the frequency of supply, so that in the elementary multipolar motor shown in fig. 3, the speed of the rotating field with the above frequency would be 25 revolutions per second, half what it was before, and that of the rotor not quite this.

If the one set of stator coils is wound exactly in between that of the second set, and if the magnetising effect of each set is the same, then the rotation of the field will be perfectly uniform, provided that the two-phase currents supplied to the motor are of equal E.M.F., exactly 90° apart, and follow a sine function.

Under these conditions, the magnetising force at any instant of one set of stator coils is equal to $H_m \sin \theta$, and that of the other set $H_m \sin (\theta - 90°)$ or $H_m \cos \theta$, where H_m is the maximum magnetising force of either set and is constant, and θ is a measure of the field's angular motion. The resultant magnetising effect at any instant (H_r) is therefore equal to $\sqrt{(H_m \sin \theta)^2 + (H_m \cos \theta)^2} = H_m$.

That is, it is absolutely constant in amount, and such a resultant must have, from its nature, a constant variation. Hence it can be plotted in such a vector diagram as fig. 4, which shows the magni-

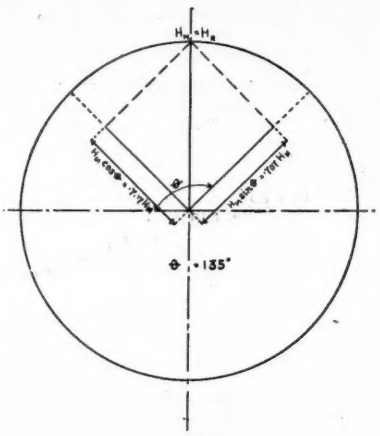


Fig. 4.

tude and direction of the two magnetising forces and their resultant when the two former have equal values. This would correspond to 135° in fig. 2.

Such vector diagrams only hold good if the conditions given above are accurately fulfilled. Thus if the sets of magnetising coils on the stator are not accurately at right angles to one another, or if their magnetising effects are not equal, the motion of the resultant field will be elliptical, and cannot be represented as in fig. 4. The motion will also be elliptical if the applied E.M.Fs. are unequal, or if one phase is not accurately 90° displaced from the other phase. If the current curves do not follow a sine law, even if all the other conditions are fulfilled, the resulting field is uneven. The effect of a peaked current curve on the resulting field, due to two-phase currents, is shown in fig. 5, and that of a flat-topped curve in fig. 6. The dotted circles show what the resultant field would have been under the normal conditions, if the current curves had followed sine functions. The tendency of distorted curves of current is to cause the magnetism to rotate by jumps.

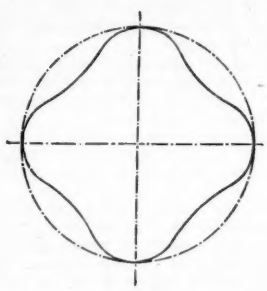


Fig. 5.

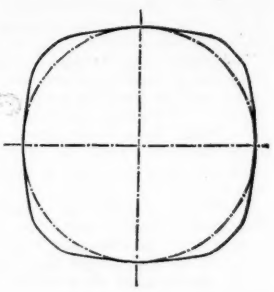


Fig. 6.

There is yet another cause that may affect the evenness of the rotary field in multiphase induction motors. If the stator iron be worked at a high induction, then as the magnetising force varies owing to the exciting currents rising or falling in value, the induction in the iron does not follow these variations—this will be at once apparent if the case is considered of the effect of working the iron over the bend of its magnetisation curve—when a very large alteration in the excitation causes but a small change in the induction. Of course, the remedy for this is to use quite low values of induction in the system; and this is what is always done in practice. Usually, its maximum value in the air-gap is about 3,000 lines per sq. cm. for 40 ~, this decreasing as the frequency is raised.

It may be perhaps, asked, What effect has an irregular field on the performance of induction motors? There are several reasons; for instance, an elliptical field means that the induction sometimes reaches high limits—this tends to increase all iron losses, at the same time increasing the self-induction—the effect of this latter being to decrease the output for a given weight, diminish the starting torque, and also the power factor at all loads.

Again, if the currents supplied to a two-phase motor are not sine functions, the components of the curve with a frequency higher than

that of the fundamental frequency set up a rotating field of their own in the reverse direction to that of the main field. The effect of the "back torque" produced may be felt in several ways. With the motor running light it acts like a small load—hence it increases the slip, and consequently the no load current. When running the idle current will be greater, and the loading limit of the motor smaller. Moreover, the motor would not start so well, and would take a larger current. The only component, however, that affects the motor to any extent is that of three times the field frequency.

As the requirements of the case necessitate a generator with an iron armature (ironless disc armatures being quite unsuitable for power work), it follows that the current curves will not in general follow sine laws, owing to the considerable self-induction which such an armature must necessarily have. Now a motor operated by three-phase currents, that is, three currents of the same periodicity, but with a phase difference of 120° between them, is (theoretically) not affected so much by departures from the theoretical conditions as a two-phase motor. Further, by their use, a considerable saving in the cost of line material can be made when transmitting power over long distances. For these reasons, but principally, the author believes, on account of the last, three-phase systems have been introduced.

Fig. 7 shows an elementary three-phase motor. The rotor can be (and in practice is) the same as for a two-phase motor. The currents

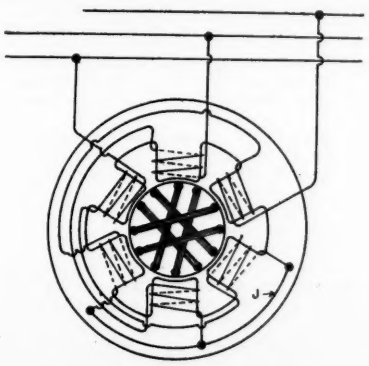


Fig. 7.

in the line have a phase difference of 120°, and the stator coils of the motor are in three sets, 120° apart. The action that takes place is similar to that in the two-phase motor, the action of the three fields across one another resulting in a rotating field of constant speed and intensity, which causes rotation of the rotor just as in the other case, its speed departing from synchronism as it is loaded up. In the case shown, the field makes one revolution per cycle, the same rule for speeds holding good.

The distinctive feature of a three-phase system is that the sum of the three current values at any instant = 0. This means that one line is always acting as a return for the other two, and implies that the three circuits in generator and motor are inter-connected. This will be seen to be the case in fig. 7, where the ends of each set of windings have a common junction at J. This particular form of winding is shown diagrammatically in fig. 8A; it is known as the "star" grouping, and is the series arrangement of coils.

Fig. 8A. Fig. 8B.

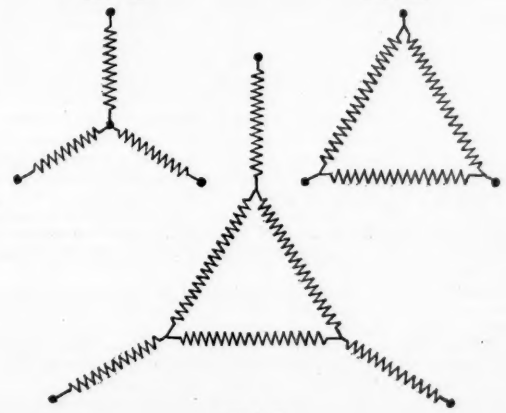


Fig. 8C.

Figs. 8B and 8C show two other ways of connecting up the circuits of a three-phase motor or generator. Fig. 8B is the parallel arrangement, and is known as the "mesh" grouping, while fig. 8C is a combination of "star" and "mesh."

The relation of motor E.M.Fs. and currents to line E.M.Fs. and currents is different with the different arrangements of the coils. Thus with the star arrangement the line currents are evidently the same as the currents in the respective coils. The line pressure is, however, $\sqrt{3}$ times the pressure between any one line and the common junction, because the pressure in any one set of coils is 30° ahead of the line pressure. If the motor circuits are all alike, and symmetrical in every way, the energy absorbed by a motor with star connected stator is

$$3 \times \frac{E}{\sqrt{3}} \times C \times \cos\phi$$
$$= 1{\cdot}73\ E\ C \cos\phi$$

where E is the pressure between any two lines.
" C " current in any one line.
" ϕ " angle of lag in any motor circuit.

In the mesh arrangement the E.M.F. on each coil is identical with the line pressure; but the current in any one line is $\sqrt{3}$ times the current in the corresponding set of motor coils, because this latter is the resultant of the currents in the two other sets of coils. The expression for the power is therefore the same as before. The "star" and "mesh" groupings are those most generally employed in practice, their combinations (of which there are several) being reserved for special cases.

In general it may be said that all those causes that are detrimental to the action of a two-phase motor also affect the three-phase motor, but to a lesser degree. Thus, for instance, fig. 9 shows the effect of a peaked current curve on the rotary field produced by three-phase

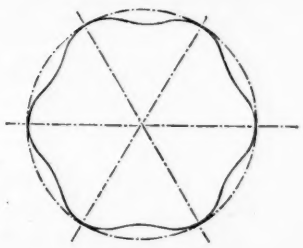


Fig. 9.

currents. It should be compared with fig. 5, when it will be seen that the fluctuation of field strength is not so marked as with the two-phase arrangement. Also, if the current curve be distorted from a sine curve, the component ripples come into play, but not to the same extent as in the two-phase motor. Those of three times the frequency of supply are the only ones that would be harmful to any extent, and these, in a case of a three-phase motor, simply create a stationary idle field, which only tends to increase the iron losses.

A further comparison of two and three-phase motors will be made later.

The reversal of multiphase induction motors, whatever the number of phases, is produced by changing over the connections of one phase of the stator winding. This has the effect, if the motor is running, of rotating the field in the opposite direction to that of the rotor, thus causing the rate of cutting lines to be very great. As a consequence, a large torque is produced, which enables the motor to reverse and run up to speed again very quickly.

(To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, March 16th, Mr. John Wolfe Barry, C.B., F.R.S., the president, in the chair, the paper read was on "The Mond Gas-Producer Plant and its Application," by Mr. H. A. Humphrey, Assoc.M.Inst.C.E.

The advantages of gaseous over solid fuel had led to an increasing demand for gas-producers to convert the solid fuel into the gaseous state. Gas producers had hitherto been constructed to make gas with little regard to by-products, and none had been made to give good results with cheap slack coal, and where the use of gas for gas engines was concerned only expensive fuel, such as anthracite or coke, had been found available. The Mond producer and recovery plant described in the paper not only employed cheap bituminous fuel, but recovered from it 90 lbs. of sulphate of ammonia per ton and yielded a gas eminently suitable for use in gas engines and applicable to all cases of furnace work.

In dealing with the application of the Mond producer plant, the author was able to give the actual figures obtained at Winnington, where Mond gas had been applied to the following purposes:—(1) Furnace and boiler heating; (2) The manufacture of steel; (3) Motive power. In each case great economy arose from its use. In a Babcock-Willcox boiler the gas from 1 ton of fuel evaporated over 7 tons of water from and at 100° C., and the gas had proved eminently suited for use in the manufacture of steel.

In 1894 the author had carried out the first experiments in the application of Mond gas to the generation of mechanical power. The trial of a 25 nominal H.P. Otto-Crossley gas engine gave most satisfactory results, 2,166 I.H.P. hours being obtained per ton of fuel in the producers, the thermal efficiency of the engine being 23·8 per cent. A much larger engine was being erected to drive a dynamo with an output of 75,000 watts. For purposes of comparison, tables

relating to Dowson and Lencauchez producers were given. In order to better realise what might be accomplished in the way of cheap power supply, the case of a 10,000 H.P. central station was considered to show the design of the gas-producers and recovery plant suitable for providing the necessary gas for this power. A summary of the advantages to be derived from central power stations on the lines indicated concluded the paper.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

6,081. "Improvements in apparatus for electric lighting." J. H. McLean. Dated March 8th.

6,087. "An improved electric circuit closing thermometer." J. Kent and W. Lingley. Dated March 8th.

6,155. "Electrical road traction installations worked by means of both alternating and continuous currents." Max Deri. Dated March 9th. (*Complete.*)

6,178. "An improved device for preventing certain induction effects in electric telephones." H. Messing. Dated March 9th.

6,188. "Improved means applicable for use in the electrolysis of salts." J. Hargreaves. Dated March 9th.

6,197. "Improvements in or relating to electric apparatus for governing engines." J. Snow and A. G. Cooper. Dated March 9th.

6,212. "Improved means for supplying electric current to electrically operated time keeping mechanism." A. W. Staveley, I. H. Parsons and T. J. Murday. Dated March 9th.

6,243. "Improvements in and relating to the protection and support of underground electric conductors." H. S. Cowx. Dated March 10th.

6,246. "Improvements in electric arc lamps." R. Dobson. Dated March 10th.

6,251. "A combination watch stand accumulator or storage battery and electric lantern." S. F. Walling. Dated March 10th.

6,262. "An electric brake for road or rail vehicles." D. Neale. Dated March 10th.

6,263. "An improved controlling switch for electrically propelled road or rail vehicles." D. Neale. Dated March 10th.

6,276. "Improvements in electric arc lamps." R. E. B. Crompton and E. A. N. Pochin. Dated March 10th.

6,287. "Improvements in automatic switches by clockwork and actuated by the electric current as applied to the illumination of clock and other dials for advertising purposes, signalling, and the like." W. H. Stockall. Dated March 10th.

6,303. "Improved electric incandescent lamp." R. B. Roxby. Dated March 10th.

6,305. "Improvements in multiple system telephone installations and apparatus therefor." Siemens Bros. & Co., Ltd. (Siemens and Halske, Germany.) Dated March 10th.

6,306. "Improvements in jacks for telephone exchanges." Siemens Bros. & Co., Ltd. (Siemens and Halske, Germany.) Dated March 10th.

6,307. "Improvements in pegs and their cords for telephone exchanges." Siemens Bros. & Co., Ltd. (Siemens & Halske.) Dated March 10th.

6,308. "Improvements in indicators for telephone exchanges." Siemens Bros. & Co., Ltd. (Siemens & Halske.) Dated March 10th.

6,309. "Improvements in calling off apparatus for telephone exchanges." Siemens & Co., Ltd. (Siemens & Halske.) Dated March 10th.

6,335. "Improvements in electric arc lamps." F. W. Andersen. Dated March 10th.

6,351. "Improvements in electric incandescent lamp holders." H. H. Hall and T. Clarke. Dated March 11th.

6,353. "Electrical switch or contact maker or contact breaker." F. F. Teatman and W. Donovan. Dated March 11th.

6,398. "Improvements in electricity meters." G. Hookham. Dated March 11th.

6,428. "Improvements in electrical switches." H. C. Gover, C. F. Proctor, and A. H. Bate. Dated March 11th. (*Complete.*)

6,431. "Improvements in electrical apparatus for communication between rooms and other places." G. S. Eckford. Dated March 11th.

6,484. "An improved combined brush and holder for dynamo-electric machines." J. Latham. Dated March 12th.

6,494. "An electrical destructor or cooker. An apparatus for destroying animal, vegetable, and other refuse (instead of turning it into drains), by means of heat generated by electricity; or may be used for cooking purposes." J. Hibbert. Dated March 12th.

6,545. "An improved composition for increasing the illuminating power of electric arc lamps." P. Mersch. (Date applied for under Patents, &c., Act, 1883, Section 103, 19th February, 1897, being date of application in France.) Dated March 12th.

6,563. "An insulating stud and nut for electrical storage battery plates." A. Martin. Dated March 12th.

6,616. "Improvements in the manufacture of reflectors specially applicable to electric incandescent lamps." W. Evans. Dated March 13th.

6,666. "Improvements in plummer locks and pedestal bearings for shafting and journals." J. Brockie. Dated March 13th.

6,687. "Improved means for supplying current to electrically propelled railway or tramway vehicles." J. Enright. Dated March 13th.

6,695. "Improvements relating to electric tramways and railways on the sectional conductor system." H. H. Lake. (R. Arno and A. Caramagna, Italy.) Dated March 13th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).*]

1896.

6,981. "Improvements in electric batteries." J. Entwisle. (S. N. Smith and E. S. Baring-Gould.) Dated March 31st, 1896. Relates to improvements in electric batteries. Each cell is provided with a porous cup secured in place by a short bolt fastened in the bottom of the cell. Between the cup and the walls of the cell is the zinc element in the form of an incomplete cylinder, arranged so as to be lifted off with the cover. The cover has central opening for the porous carbon cup. To overcome the usual wasting of the zinc at the top, the connection to the zinc is made at the lower end instead of the top, the connection being insulated from the surrounding liquid. 3 claims.

7,038. "Improvements in regulators for electric arc lamps." H. Baurlin. Dated March 31st, 1896. The improvement has reference to an electric arc lamp where the distance of the carbons is regulated by an electro-magnet connected in a shunt circuit with the main current circuit. This magnet has a keeper containing a clockwork with pendulum escapement moved by the weight of the top carbon clamp, the latter being suspended with a strip to a rope pulley of the clockwork, whilst the other end of said strip is attached to the lower carbon clamp, said keeper having upon its top a by-keeper whose extremity remote from the magnet, presses against a friction wheel of the clockwork. 1 claim.

9,048. "Electrical fog signalling apparatus for railways." H. Lomlins and C. R. Gurr. Dated April 29th, 1896. Relates to electrically controlled detonating or fog signal apparatus for railways. The setting of the apparatus in position to cause the explosion of the signal on the passage of the train is effected by an electric current from a signal cabin. 7 claims.

17,180. "Improvements in combined typewriters and electro-telegraphic transmitters." W. L. Wise (World Flash Company). Dated August 4th, 1896. An ordinary typewriter machine, having a series of finger keys to actuate the type bars, is here designed for unison action with an electric code transmitter governed from the same keys; the improvement permits the typewriter and the transmitter to be used singly or together, and is of special benefit in instances where a skilled operator is afflicted with telegrapher's cramp. The transmittal of the code signals is uniform and distinct, while with the typewriter in play a record is kept to verify the messages. The separate use of the typewriter enables to code signals to be transcribed as rapidly as the operator can receive the signals and manipulate the typewriter keys. 4 claims.

17,818. "Improvements in dynamo electric machines." The British Thomson-Houston Company, Limited. (D. P. Thompson and A. H. Armstrong, United States.) Dated August 11th, 1896. The invention consists in a core provided with slots in which coils are to be inserted, and having teeth of a peculiar shape. The teeth overlap a part of the slot with an L-shaped projection. The underside of the L-shaped projection is under-cut, and the rear portion of the L has a small notch also under-cut, so that a wedge may be driven over the coils to retain them in place. The opening of the slot is approximately on half of the entire slot width, and the coils are dropped into it in such a way that the insulation of the coils is not disturbed. 2 claims.

18,549. "Improvements in or relating to electrical primary batteries." J. B. Whittemore. Dated August 21st, 1896. Relates to a method of preparing coal for use in primary batteries and consists in taking a block of coal of convenient size and burning upon it pitch or other inflammable substance. When the inflammable substance is completely burnt away the coal is ready for use in a water liquid cell, or as a means for augmenting the electrical properties of an acid solution cell. 4 claims.

18,651. "Improvements in commutator brush holders for dynamo electric machines or electric motors." H. H. Lake. (R. Lundell, United States.) Dated August 22nd, 1896. Relates to a commutator brush holder provided with means for giving to the brush continuous pressure against the stationary part of the holder and also against the commutator. 7 claims.

18,593. "Improvements in cores of dynamo electric machines and other electrical apparatus." J. F. Kelly. Dated August 22nd, 1896. Relates to a method of preventing "core loss" by adding to the laminated iron core, silicon above the normal quantity formed in iron for that purpose. 3 claims.

18,652. "Improvements relating to conductors and switches for electric railways." H. H. Lake. (R. Lundell.) Dated August 22nd, 1896. Has reference to electric railways of the kind disclosed in specification of a prior patent No. 10,804 of 1895, and refers to certain improvements relating to conductors and switches for electric railways. 10 claims.